Missouri Department of Transportation

Bridge Division

Bridge Design Manual

Section 3.77

Revised 05/28/2004

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Index

DESIGN UNIT STRESSES (also see Section 4 - Note A1.1)

(1) Reinforced Concrete

Class B Concrete (Substructure) fc = 1,200 psi f'c = 3,000 psi

Reinforcing Steel (Grade 60) fs = 24,000 psi fy = 60,000 psi

n = 10

$Ec = W^{1.5} \times 33\sqrt{f'c}$ (AASHTO Article 8.7.1) (*)

(2) Structural Steel

Structural Carbon Steel (ASTM A709 Grade 36)

fs = 20,000 psi fy = 36,000 psi

(3) Piling

For pile capacity, see Bridge Manual Sec. 1.4 and 3.74. Also, see the Design Layout if pile capacity is indicated.

(4) Overstress

The allowable overstresses as specified in AASHTO Article 3.22 shall be used where applicable for Service Loads design method.

(*) $E_C = 57{,}000\sqrt{f'c}$ for W = 145 pcf, $E_C = 60{,}625\sqrt{f'c}$ for W = 150 pcf

LOADS

(1) Dead Loads

As specified in Bridge Manual Section 1.2.

(2) Live Load

As specified on the Design Layout.
Impact of 30% is to be used for design of the beam. No impact is to be used for design of any other portion of bent including the piles.

(3) Temperature, Wind and Frictional Loads

See Bridge Manual Section 1.2.4.

DISTRIBUTION OF LOADS

(1) Dead Loads

Loads from stringers, girders, etc. shall be concentrated loads applied at the intersection of centerline of stringer and centerline of bearing. Loads from concrete slab spans shall be applied as uniformly, distributed loads along the centerline of bearing.

(2) Live Load

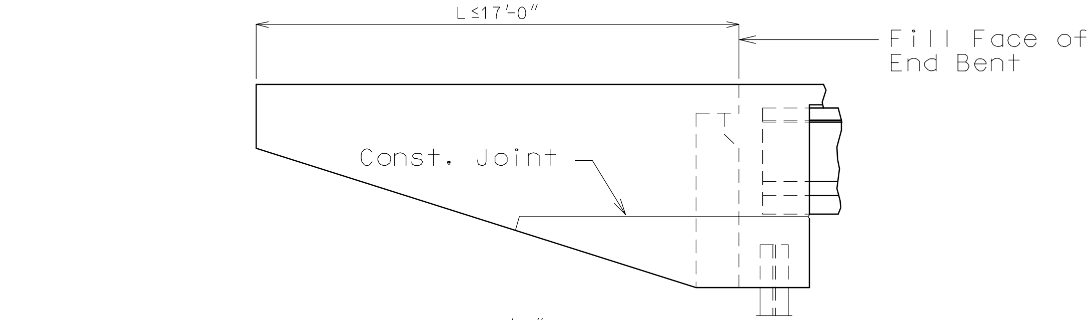
Loads from stringers, girders, etc. shall be applied as concentrated loads at the intersection of centerline of stringer and centerline of bearing. For concrete slab spans distribute two wheel lines over 10'-0" (normal to centerline of roadway) of substructure beam. This distribution shall be positioned on the beam on the same basis as used for wheel lines in Traffic Lanes for Substructure Design (See Section 1.2).

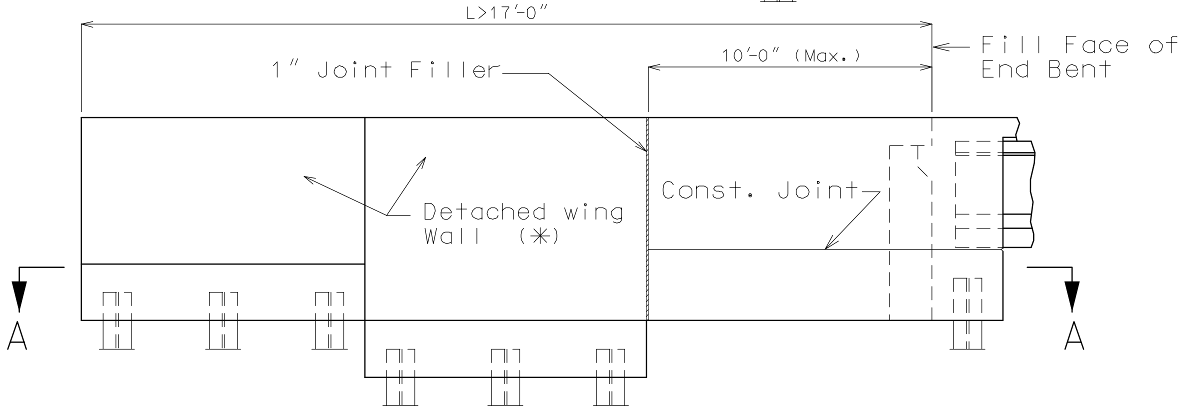
(3) Wing with Detached Wing Wall

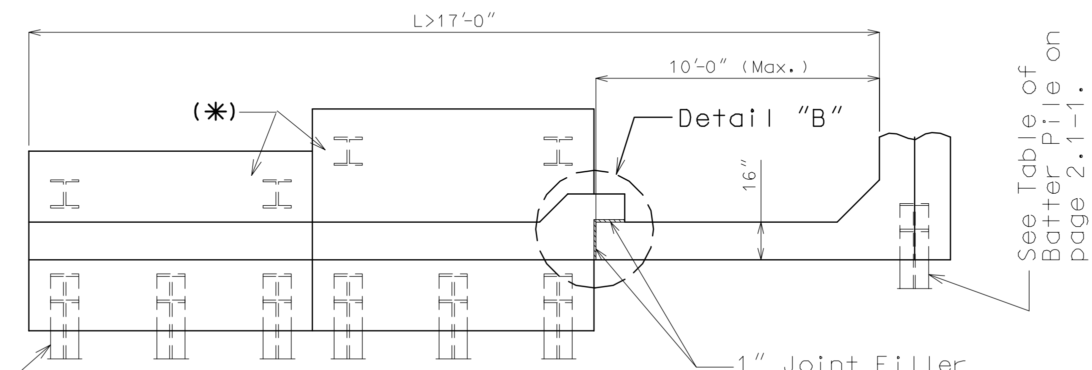
When wing length, L, is greater than 17'-0", use maximum length of 10'-0" rectangular wing wall combined with a detached wing wall, see page 1.1-2 of this section. When detached wing walls are used, no portion of the bridge live load shall be assumed distributed to the detached wing walls. Design detached wing wall as a retaining wall, see Sec.3.62 for retaining wall design. (The weight of Safety Barrier Curb on top of the wall shall be included in Dead Load.)

DISTRIBUTION OF LOADS (CONT.)

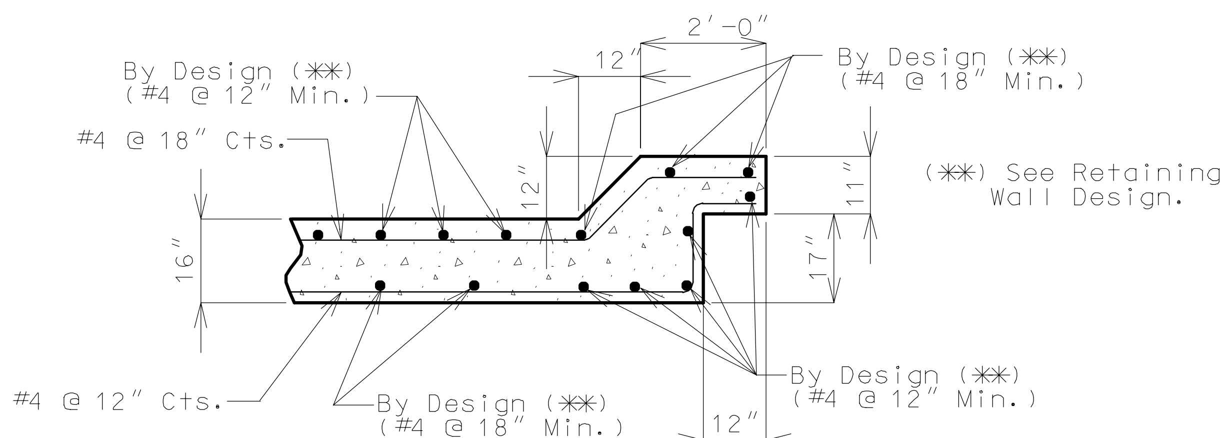
(3) Wing With Detached Wing Wall (Cont.)







SECTION A-A



DETAIL "B"

(*) Detached wing wall shown is for illustration purpose only. Design detached wing wall as a retaining wall, see Section 3.62 of this manual.

DESIGN ASSUMPTIONS - LOADINGS

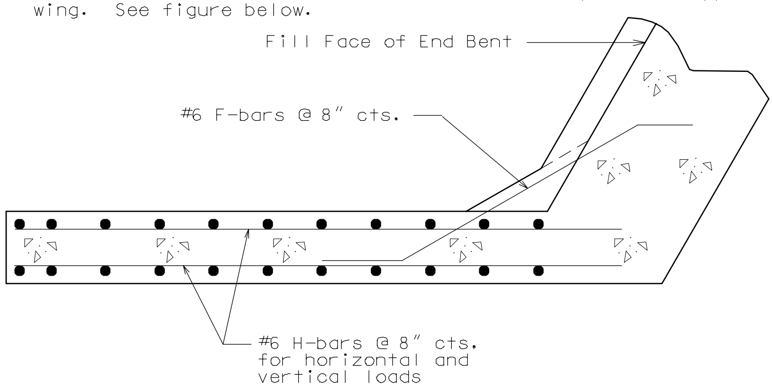
(1) BEAM

The beam shall be assumed continuous over supports at centerline of piles.

One half of the dead load of the approach slab shall be included in the beam design.

(2) WING

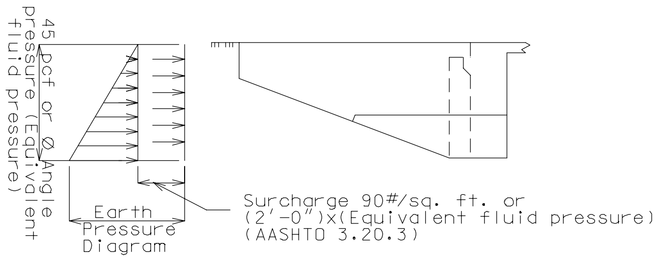
(a) The minimum steel placed horizontally in wings shall be #6 @ 8" centers, each face. These bars should be adequate to support the wing. See figure below.



PART SECTION THRU BEAM

(b) Earth Pressure

Design horizontal reinforcement for soil pressure and live load surcharge. See design example 1.



(c) Seismic Load

Check horizontal reinforcement when seismic shear force applies at end bents. Add intermediate wing(s) if additional seismic resistant is required. See design example 2.

(3) PILES

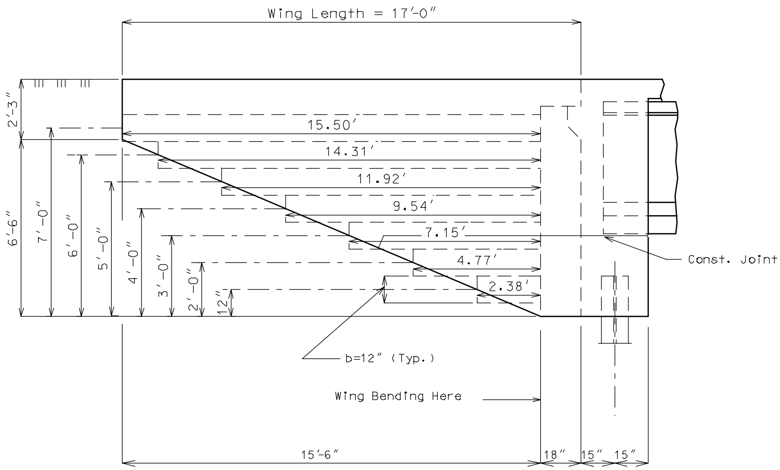
(a) Bending

Stresses in the piles due to bending need not be considered in design calculations, except for seimic design.

(b) Dead Loads, etc.

Dead load of superstructure, substructure and one half of the approach slab will be distributed equally to all piles which are under the main portion of the bent.

EXAMPLE 1: Design horizontal reinforcement of the following wing with wing length of 17'-0". Use 90 psf for live load surcharge and 45 psf/linear foot for earth pressure (Use load factor design).



SOLVE:

Factored Soil Pressure = 1.3γ x45 psf/ft = 1.3x1.3x45 psf/ft = 76.05 psf/ft.
Factored Surcharge = 1.3 γ x90 psf = 152.1 psf. (AASHTO 5.14.1, 5.14.2)

Find the bending moment of wing about edge of brace due to earth pressure and live load surcharge:

1st foot from bottom of wing (h=7.75'):

EP = Earth Pressure = Soil Pressure + Surcharge
EP = 7.75'x76.05 psf/ft + 152.1 psf = 741.5 psf
M = Moment = 741.5 psf x (2.38'x1') x 2.38'/2 = 2100 ft.-lb.

2nd foot from bottom of wing (h=6.75'):

EP = 6.75'x76.05 psf/ft + 152.1psf = 665.4 psf
M = 665.4 pst x (4.77'x1') x 4.77'/2 = 7570 ft.-lb.

3rd foot from bottom of wing (h=5.75'):

EP = 5.75' x 76.05 psf/ft + 152.1 psf = 589.4 psf
M = 589.4 psf x (7.157'x1') x 7.157'/2 = 15,065 ft.-lb.

4th foot from bottom of wing (h=4.75'):

EP = 4.75' x 76.05 psf/ft + 152.1 psf = 513.3 psf
M = 513.3 psf x (9.54'x1') x 9.45'/2 = 23,358 ft.-lb.

5th foot from bottom of wing (h=3.75'):

EP = 3.75' x 76.05 psf/ft + 152.1 psf = 437.3 psf
M = 437.3 psf x (11.92'x1') x 11.92'/2 = 31,067 ft-lb.

6th foot from bottom of wing (h = 2.75'):

EP = 2.75' x 76.05 psf/ft + 152.1 psf = 361.2 psf
M = 361.2 psf x(14.31'x1')x14.31'/2 = 36,983 ft-lb. ← Control

7th foot from bottom of wing (h=1.75'):

EP = 1.75' x 76.05 psf/ft + 152.1 pst = 285.2 psf
M = 285.2 psf x (15.5'x1') x 15.5'/2 = 34,260 ft.-lb.

DESIGN EXAMPLE (CONT.)

Design

Example 1 (Cont.)

Mu=36,983 ft-lb, f′c=3000 psi, fy=60 ksi, assume #6 vertical bar and #6 horizontal bar.

Wing wall thickness = 16″

Effective d = 16″-2″Clear(exposed to earth)- 0.75″(vert. bar)- 0.375″(horiz. bar)
= 12.875″

b = 12″, Ø = 0.9

$$As = \frac{0.85\ f'c\ b\ d}{fy}\left[1-\sqrt{1-\frac{2\ Mu\ (12''/ft.)}{0.85\ f'c\ Ø\ b\ d^2}}\right]$$

$$= \frac{(0.85)(3)(12'')(12.875'')}{60}\left[1-\sqrt{1-\frac{(2)(36{,}983)(12)}{(0.85)(3000)(0.9)(12)(12.875)^2}}\right]$$

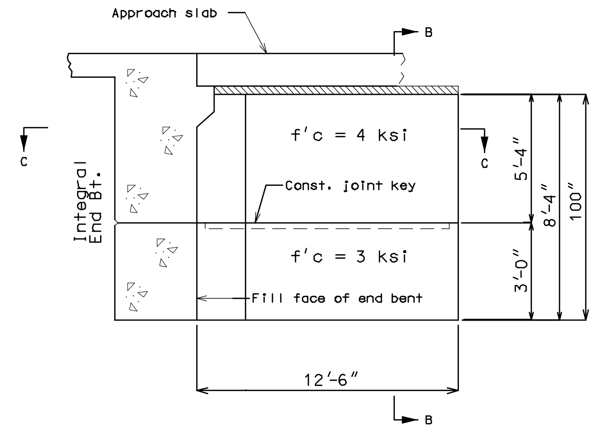
= 0.673 sq. in.

Use #6 @ 8″ cts. (As = 0.663 sq. in.)

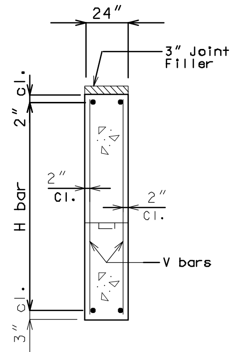
Use #6 @ 8″ cts. Horizontal Bars and use #6 @ 8″ cts. Wing Brace Reinforcing Bars

DESIGN EXAMPLE
Example 2

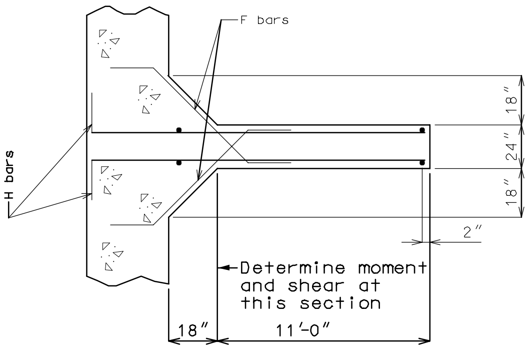
Design H-bar and F-bar of an intermediate wing as shown in the figures below (wing length = 12.5', wing thickness = 24", wing height = 8'-4"), a Seismic Force of ω = 12.21 kips/ft. is applied on the wall.



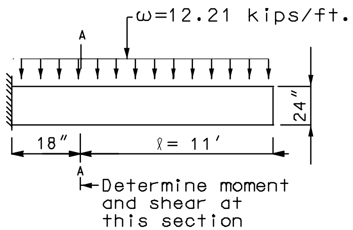
SECTION NEAR INTERMEDIATE WING



SECTION B-B



SECTION C-C



Interior Wing Design

Solve: Assume #6 V bar, #8 H bar, #6 F bar

1/ Design H-bar for bending

d = 24"-2"(clr.)-0.75"(V bar)-0.5x1"(H bar) = 20.75",
ℓ = 11', ω = 12.21 kips/ft., b = 8'-4" = 100"

At section A-A:
$Mu = (1.0)(\omega\ell^2/2) = 12.21 \times 11^2/2 = 738.705$ kips-ft.

$Ru = Mu/(\varnothing bd^2) = 738.705 \times 12{,}000/(0.9 \times 100" \times (20.75")^2) = 228.85$ psi

use f'c = 3 ksi, fy = 60 ksi

$m = fy/(0.85\ f'c) = 60/(0.85 \times 3) = 23.53$

$\rho = (1/m)\left[1-\sqrt{1-2Rum/fy}\right] = (1-\sqrt{1-2 \times 228.85 \times 23.53/60000})/23.53 = 0.004003$

As (Req'd) = ρ bd = 0.004003x100"x20.75" = 8.31 sq. in.

Try #8 @ 9", USE $\dfrac{100"-3"(clr.)-2"(clr.)-1"(\#8\ bar)}{9"}$ = 10.44 spacing

Say 11 spacings, 12 bars(Each Face)

Total Area = 12 (0.7854) = 9.42 sq. in.> 8.31 sq. in., USE 12-#8 H-bar (each face)

DESIGN EXAMPLE(CONT.)
Example 2 (Cont.)

2/ Design F-bar for shear

$Vu \le Ø(Vc + Vs)$, $Ø = 0.85$ (AASHTO Article 8.16.6.1.1)

At Section A-A:
$Vu = 1.0x(\omega\ell) = (12.21\ kips/ft.)(11') = 134.11\ kips$

$Vc = bd(\nu c) = bd(2\sqrt{f'c}) = (100''x20.75'')(2x\sqrt{3000})/1000 = 227.30\ kips$

$Ø\ Vc = 0.85Vc = 0.85x227.30\ kips = 193.20\ kips$

$Ø\ Vc = 193.20\ kips > Vu = 134.11\ kips$, No Vs needed by AASHTO Article 8.16.6.3.1.

$0.5(Ø\ Vc) = 0.5x193.20 = 96.60\ kips < Vu = 134.11\ kips$.

Minimum shear reinforcement is required by AASHTO Article 8.19.1.1(a).
(ACI 318-95 11.5.5.1)

F-bar is a single group of parallel bars, all bent up at the same distance from support (no "spacing" along the "L" direction of the wing).

Try #6 @ 12" F-bar (each face).

Try (100"-3"-2"-1")/12" = 7.83, say 8 spacing, 9 bars (each face).

Since seismic force is a cyclic loading, assume one bar works at any instance.

Av(provided) = 1x9x(0.4418 sq.in.) = 3.98 sq. in.

$Vs = Av(Fy\ Sin\ 45°) = (3.98\ sq.\ in.)(60\ ksi)(Sin\ 45°) = 168.7\ kips$.

Check $3\sqrt{f'c}\ b_\omega d = 3\sqrt{3000}\ x100''x20.75''/1000 = 341.0\ kips$.

$Vs = Av(Fy\ sin\ 45°) \le 3\sqrt{f'c}\ b_\omega d$, O.K. by AASHTO Article 8.16.6.3.4.

USE 9 #6 F-bars (each face).

Note: The following are details and dimensions for the Plan view on the Front Sheets.

Details for unsymmetrical roadways will require dimensions tying Centerline Lane to Centerline Structure.

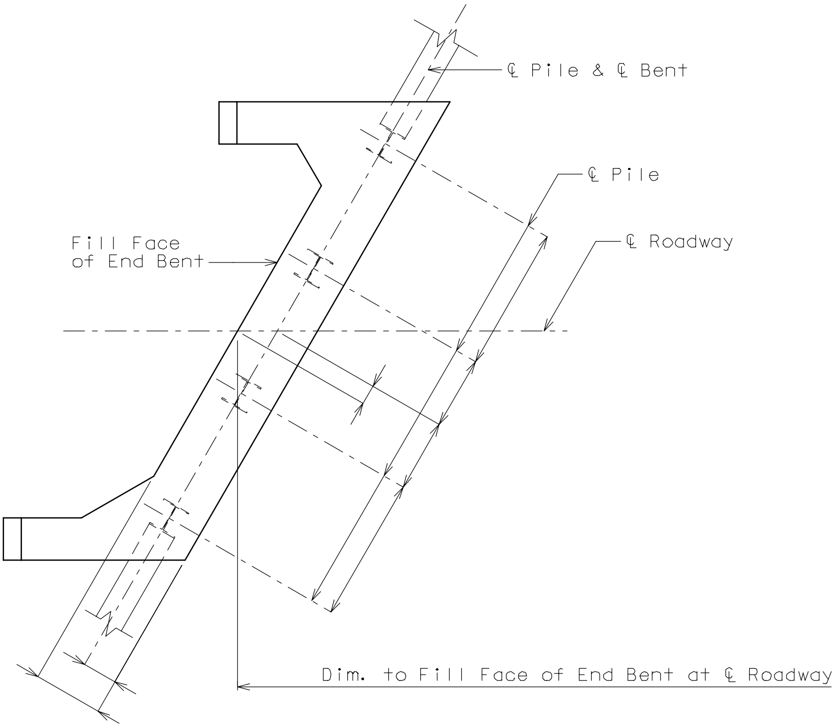
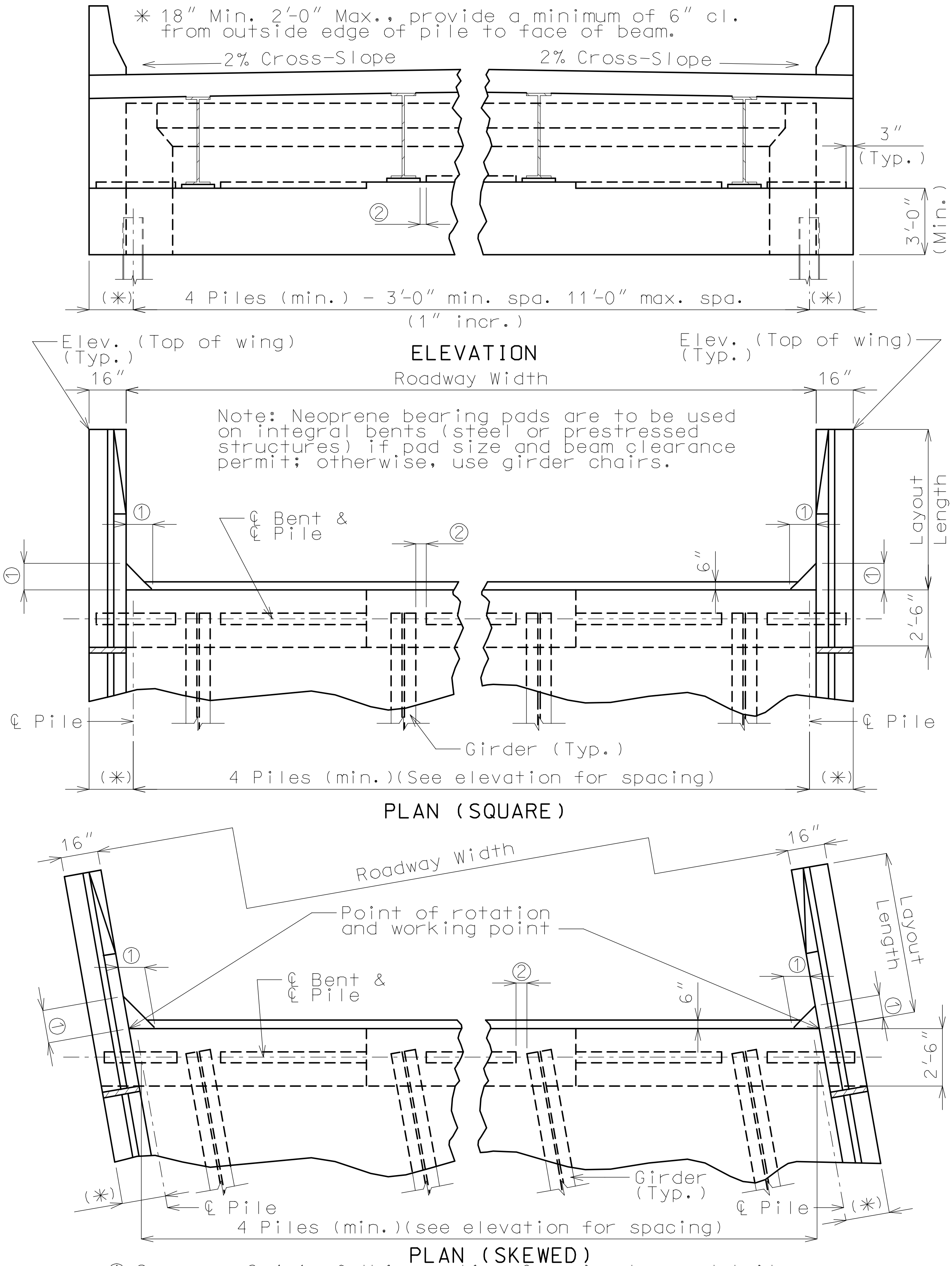


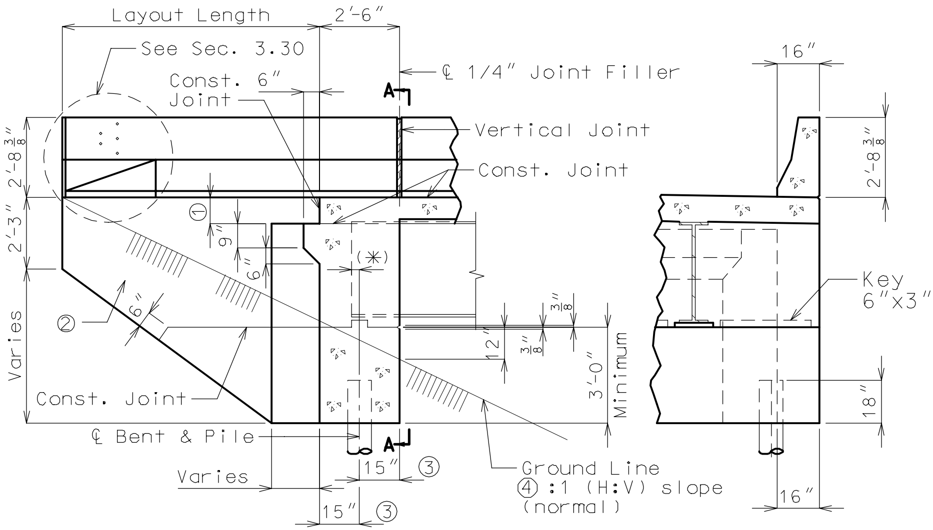
Table for Batter: Outside Piles			
	Type of Pile	Skew	Batter
SPC A	CIP Piles	All skew	No Batter
	Steel Piles	0° thru 30°	No Batter
		31° thru 44°	2″ per 12″
		45° and over	3″ per 12″
SPC B, C & D	CIP Piles	All skew	No Batter
	Steel Piles	All skew	No Batter

WIDE FLANGES BEAMS AND PLATE GIRDERS **Dimensions**

② 3" cl. between sole plate and keyed const. joint (Typ.)



① See page 2.4-1 of this section for wing brace details.



SECTION NEAR WING

SECTION A-A

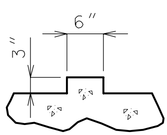
① 12" Minimum at gutter line top of concrete.

② All concrete in the end bent above top of beam and below top of slab shall be class B-2, see proper notes in Section 4 Office Notes.

③ Provide a minimum of 6" Cl.from outside edge of pile to face of beam.

④ See Design Layout for maximum slope of spill fill.

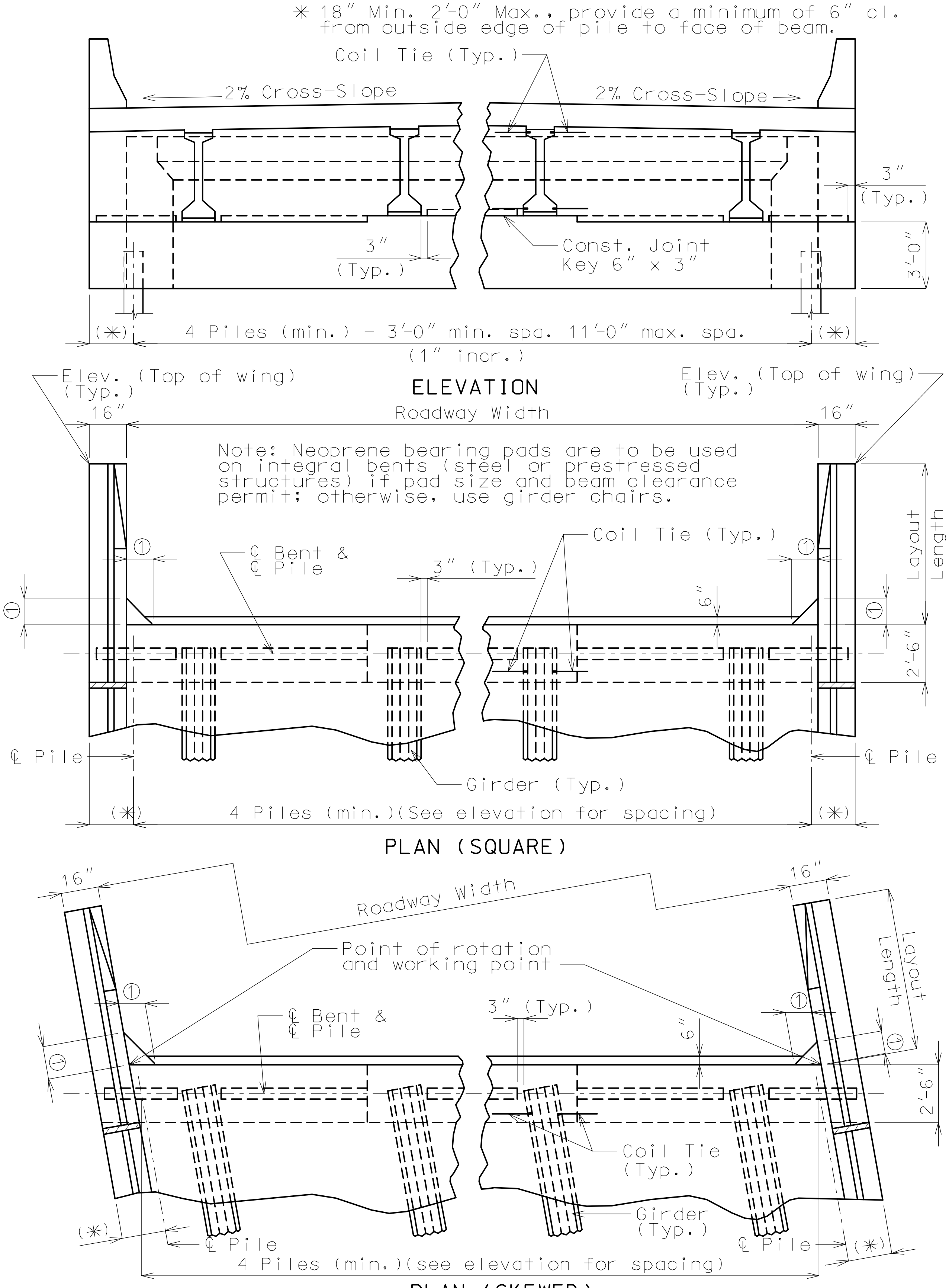
(✱) Use 3" Min. when girder chairs are used and use 1" past the end of the bearing pad when bearing pads are used.



DETAIL OF KEYED CONST. JOINT

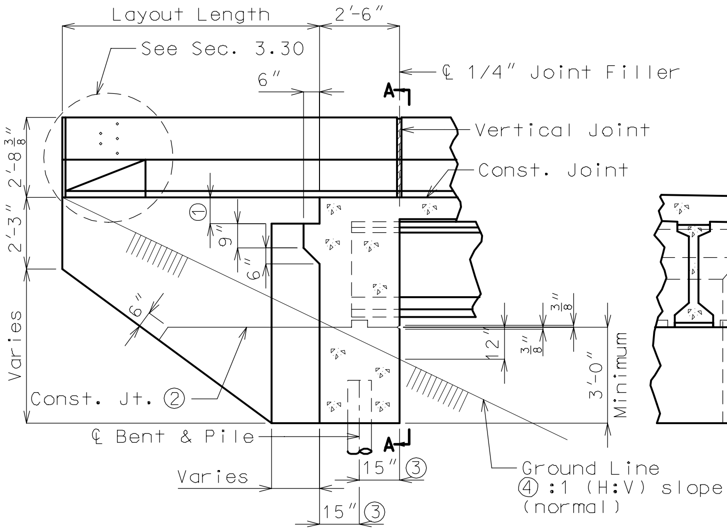
PRESTRESSED GIRDERS

Dimensions

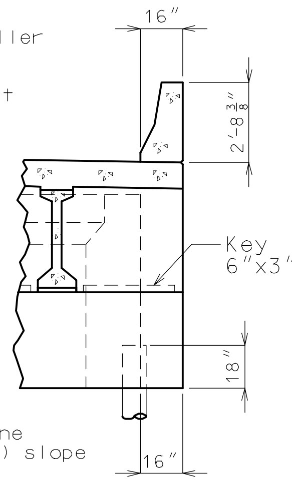


① See page 2.4-1 of this section for wing brace details.

PRESTRESSED GIRDERS (CONT.) **Dimensions**



SECTION NEAR WING



SECTION A-A

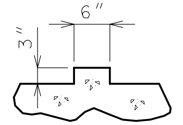
Note:

① 12" Minimum at gutter line top of concrete.

② All concrete in the end bent above top of beam and below top of slab shall be class B-2, see proper notes in Section 4 Office Notes.

③ Provide a minimum of 6" Cl. from outside edge of pile to face of beam.

④ See Design Layout for maximum slope of spill fill.

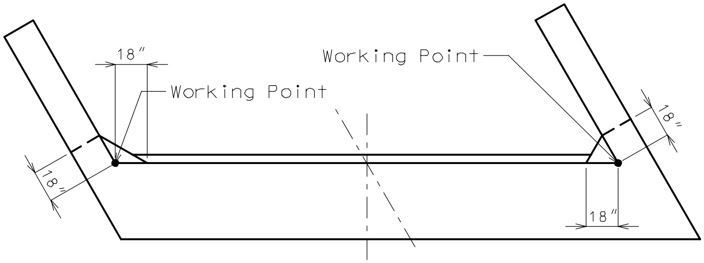


DETAIL OF KEYED CONST. JOINT

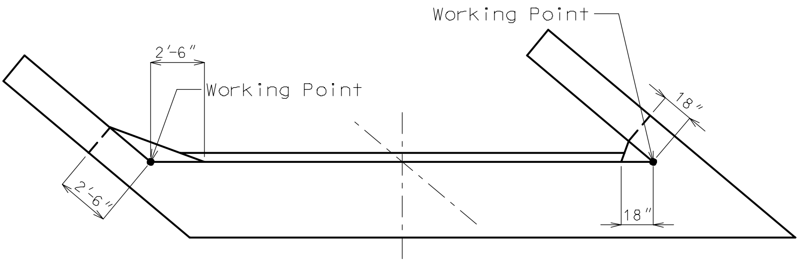
WING BRACE DETAILS

Dimensions

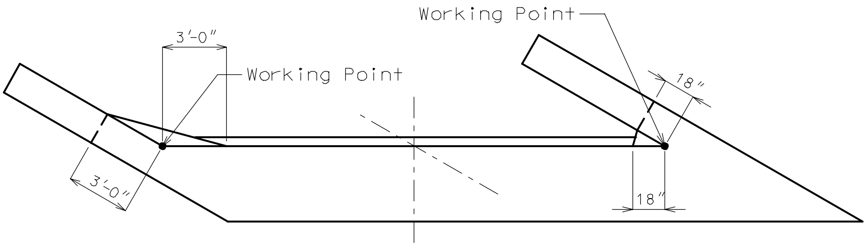
Note:
The wing brace dimensions will only vary on the wing with obtuse angle. The wing brace with the acute angle will always be 18″.



SKEWS THRU 0° TO 45°

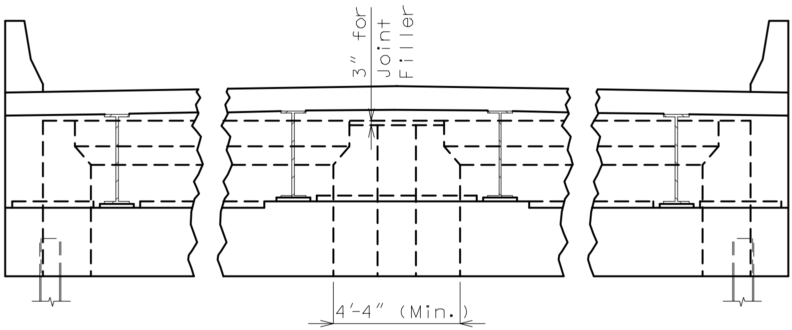


SKEWS THRU 45°00′01″ TO 55°

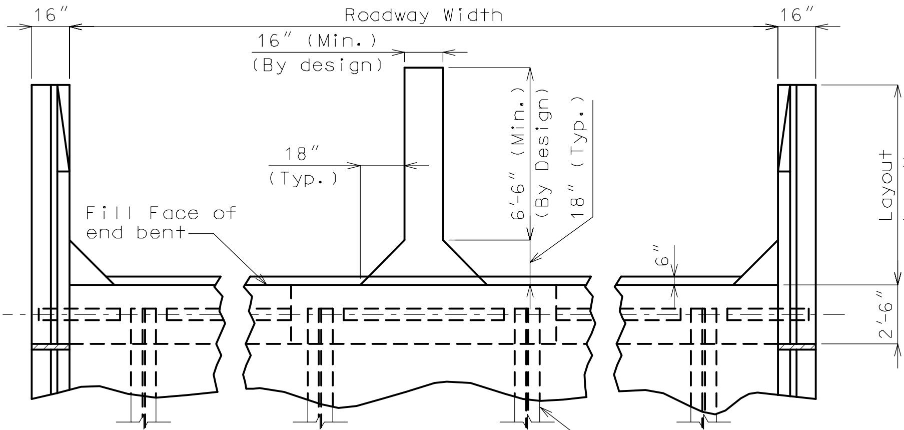


SKEWS THRU 55°00′01″ AND OVER

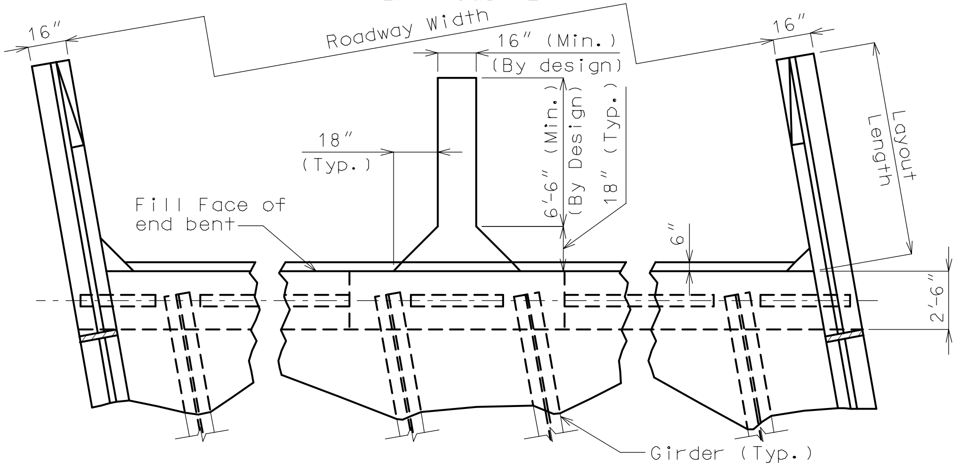
Left advance shown, right advance similar.



ELEVATION



PLAN (SQUARE)

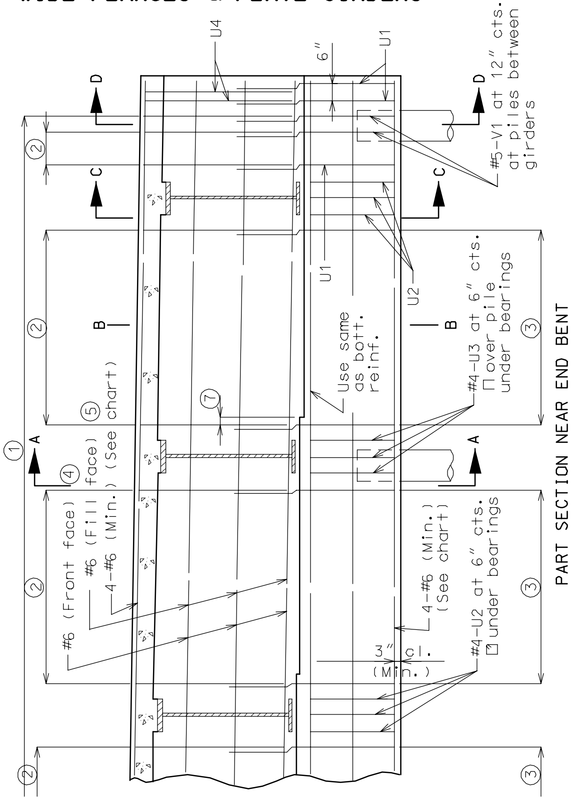


PLAN (SKEWED)

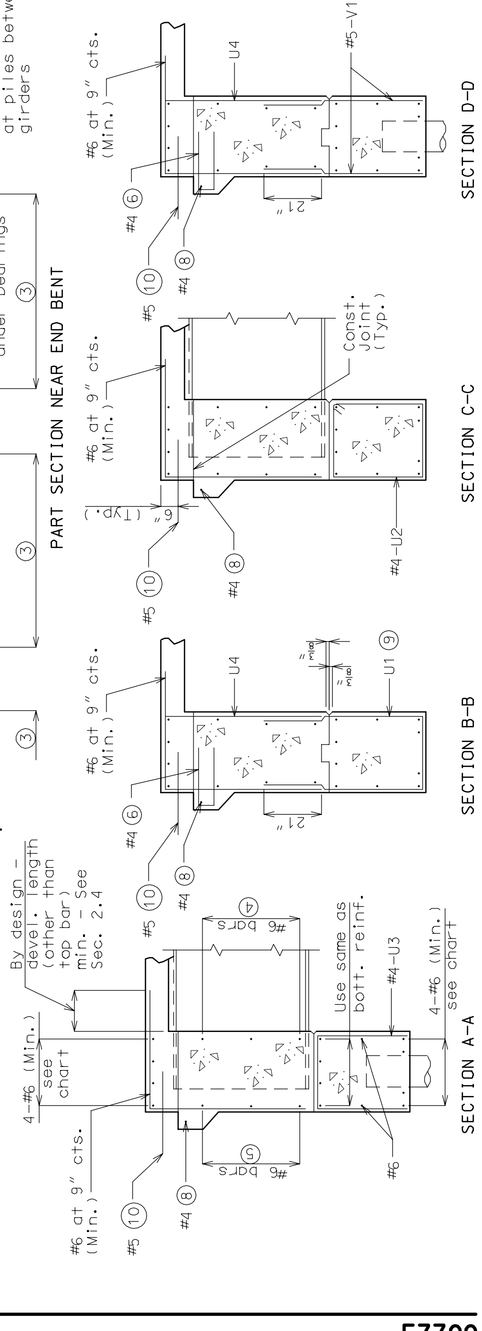
Note: Intermediate wings can match skews 10° and under.

WIDE FLANGES & PLATE GIRDERS

Reinforcement



PART SECTION NEAR END BENT



SECTION A-A

SECTION B-B

SECTION C-C

SECTION D-D

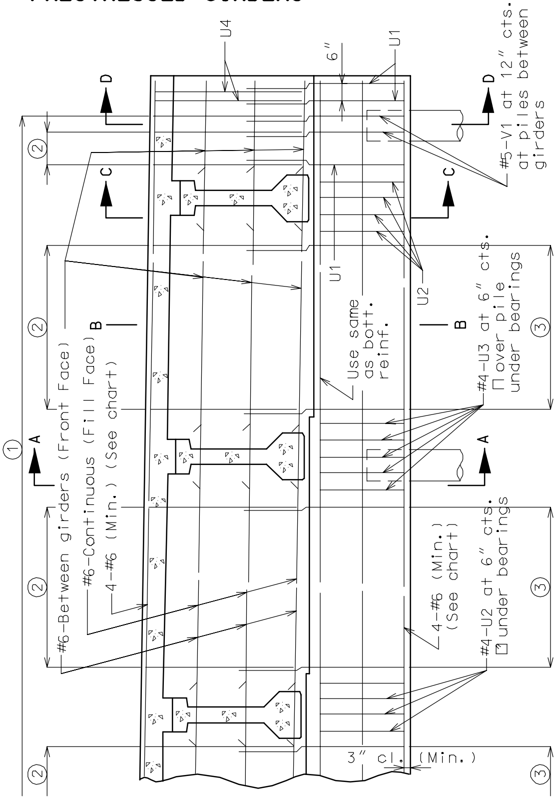
Place U1, U2, U3, U4, and V1 bars parallel to ℄ Roadway.

1. #6 at 9" cts. min. ┌ (horiz. leg placed parallel to ℄ Roadway)(Between barrier curbs).
2. #5-U4 at 12" cts. ⊓ - spaced with U1 and V1 bars.
3. U1 at 12" cts. ⊔ - spaced between piles and girders.
4. See tables on pages 4.1-1, 4.1-2 of this section for 1-1/16" Ø hole spacing for #6 reinf. bars.
5. Same spacing as 1-1/16" Ø holes in stringer or girder.
6. #4 bars ⊏ spaced with U1 & V1 bars.
7. Stirrups shall clear step by 1-1/2" min., if not lengthen step or skew step.
8. Bar length equals approach haunch length.
9. #5 bars, except special cases listed on Page 3.6-1.
10. #5 bars, 2'-6" long, spaced at about 12" cts. parallel to ℄ Rdwy.

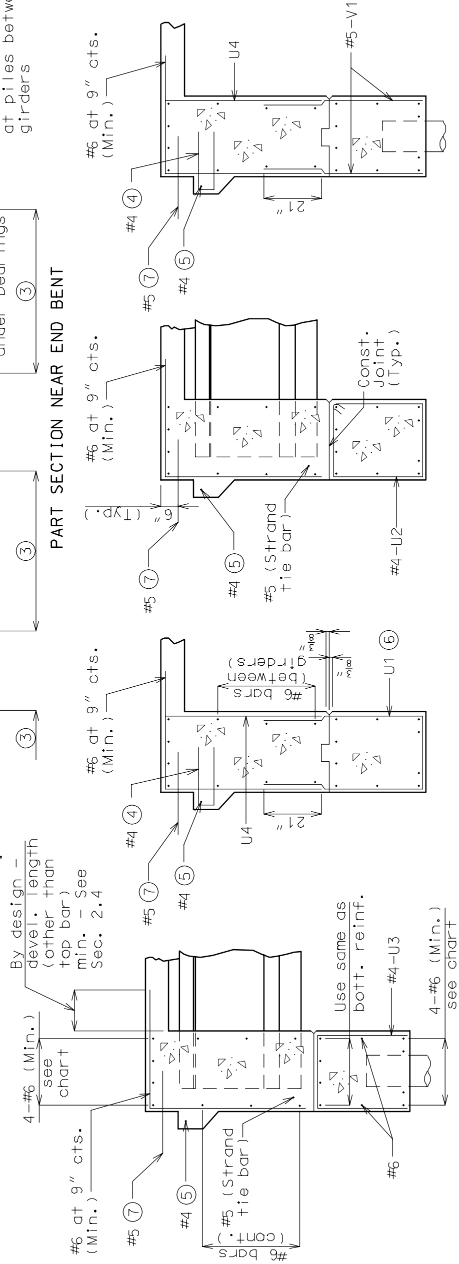
Place note on plans if Girder Chairs are used:

Shift the reinforcing steel to clear the angles of the girder chairs.

(Replace U1 bars with U3 bars at piles under girders and with V1 bars at piles between girders).



PART SECTION NEAR END BENT



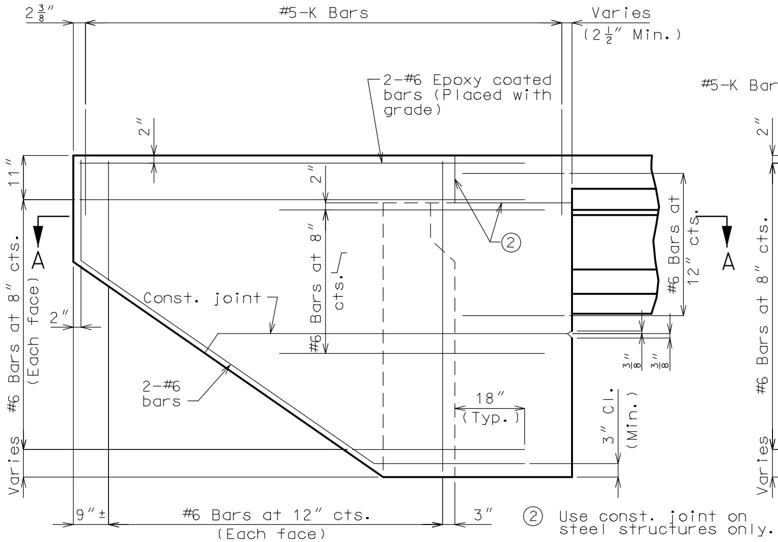
SECTION A-A SECTION B-B SECTION C-C SECTION D-D

Place U1, U2, U3, U4, and V1 bars parallel to ℄ Roadway.

1. #6 at 9" cts. min. ⌈ (horiz. leg placed parallel to ℄ Roadway)(Between barrier curbs).
2. #5-U4 at 12" cts. ⊓ - spaced with U1 and V1 bars.
3. U1 at 12" cts. ⊔ - spaced between piles and girders. (Replace U1 bars with U3 bars at piles under girders and with V1 bars at piles between girders).
4. #4 bars ⊏ spaced with U1 & V1 bars.
5. Bar length equals approach haunch length.
6. #5 bars, except special cases listed on Page 3.6-1.
7. #5 bars, 2'-6" long, spaced at about 12" cts. parallel to ℄ Rdwy.

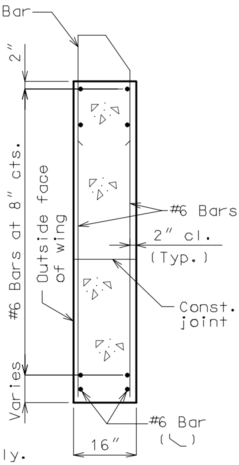
Place note on plans if girder chairs are used:

Shift the reinforcing steel to clear the angles of the girder chairs.

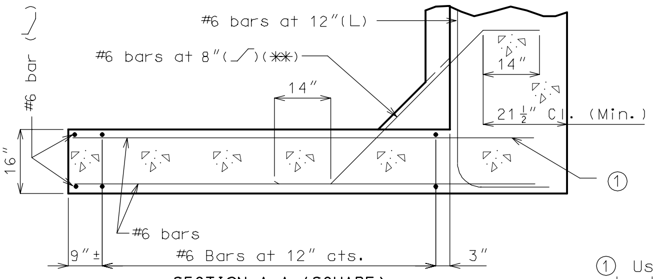


② Use const. joint on steel structures only.

ELEVATION OF WING

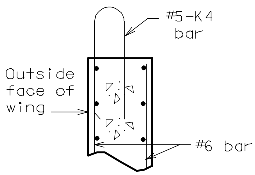


PART SECTION THRU WING



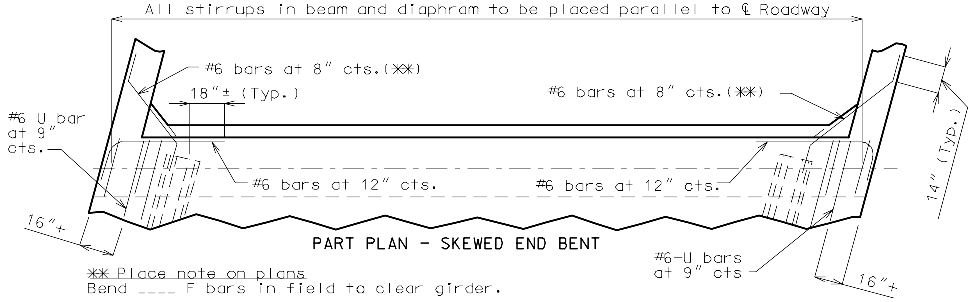
SECTION A-A (SQUARE)

(K bars not shown for clarity)



PART SECTION THRU END OF WING

① Use 90° standard hook in SPC B, C, & D.



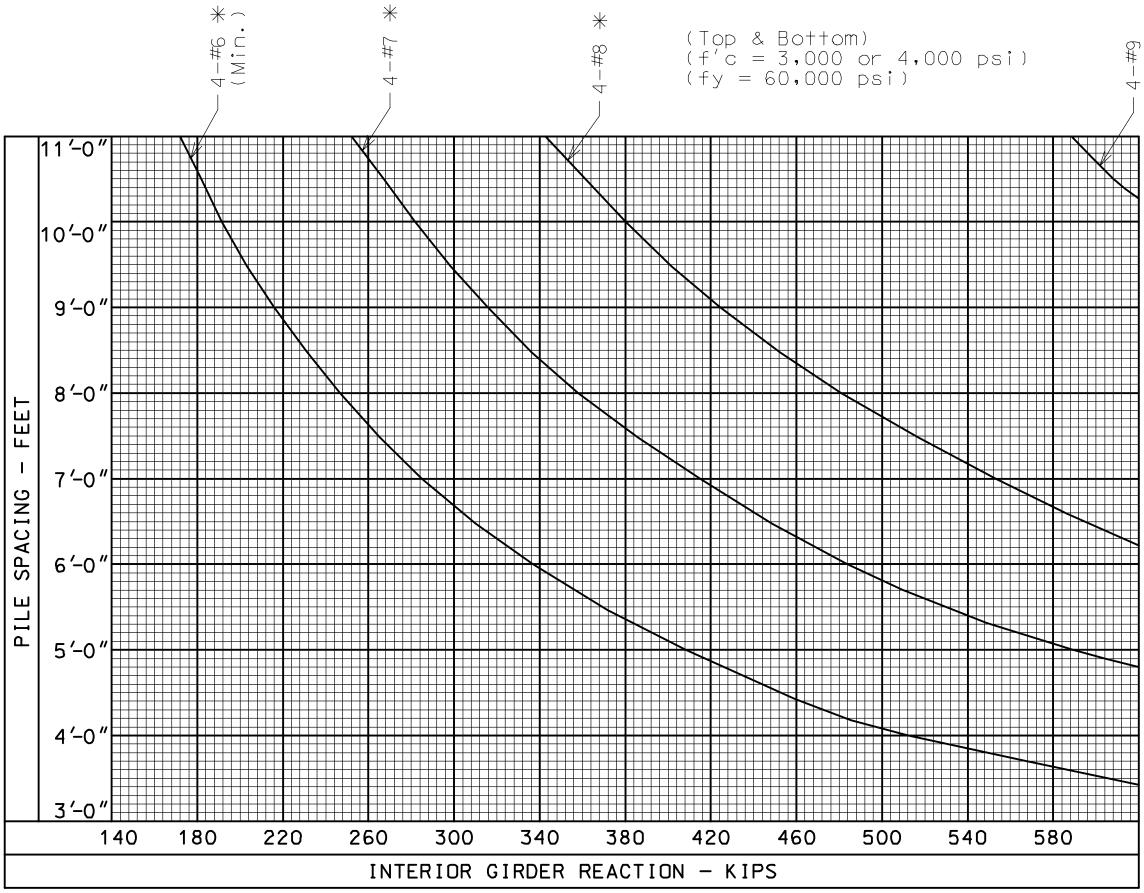
PART PLAN - SKEWED END BENT

✱✱ Place note on plans
Bend ____ F bars in field to clear girder.

Note: See Bridge Manual Section 3.30 for barrier curb details and spacing of K bars.
Prestressed I-Girders shown in details, Steel Girders similar.

WIDE FLANGES, PLATE GIRDERS & PRESTRESSED GIRDERS BEAM REINFORCEMENT CHARTS

Reinforcement

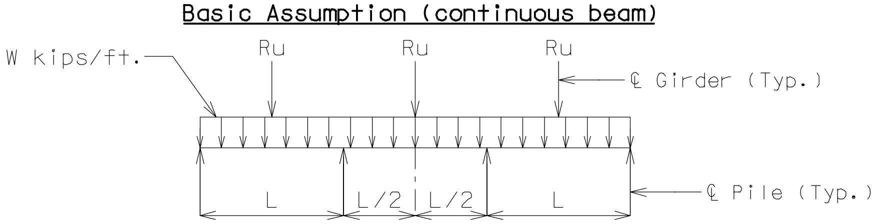


Note:
* Includes the minimum reinforcement criteria of providing reinforcement at least 1/3 greater than that required by analysis. (4-#9's meet min. reinf. as shown below.)

Interior Girder Reaction, Ru=1.3[DL(superstr.)]+2.17[(max.LL+I)(shear dist.**)]

** If the computer output for max. (LL+I) is based on the moment distribution factor, do not revise the loads for the shear distribution factor.

<u>Basic Assumption (continuous beam)</u>



Ultimate Moment = $0.2RuL + 0.13WL^2$

Where: Ru = Ultimate Interior Girder Reaction, in kips

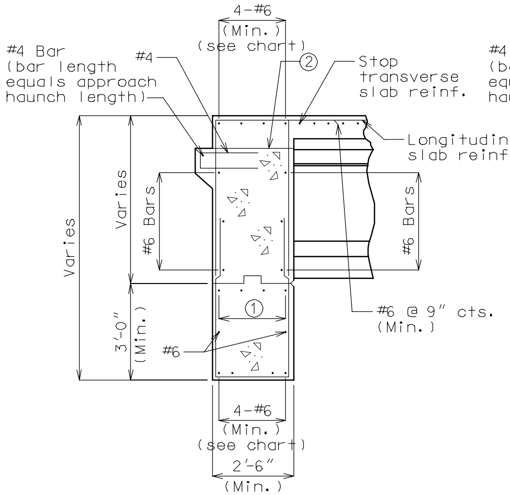
L = Pile Spacing, in feet

W = Uniform DL(substr. + 0.5 Approach Slab D.L.), in kips/ft.

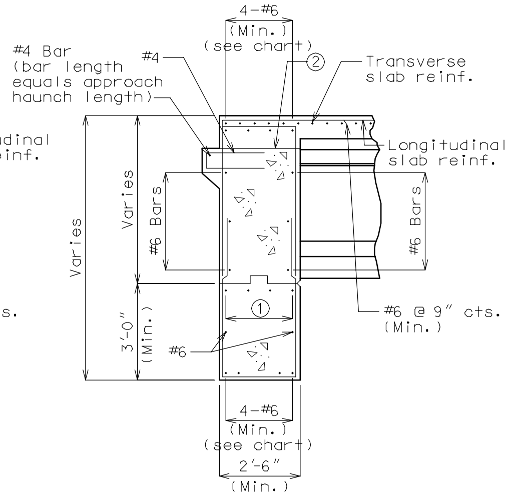
Note:
* Min. reinf., p min. = $1.7\,(h/d)^2\,(\sqrt{f'c/fy}) = 1.7\,(78.''/74.5'')^2\,(\sqrt{3{,}000/60{,}000}) = 0.001701$
Min. As = p min. (bd) = 0.001701(30")(74.5") = 3.802 sq. in. (4-#9) but need not exceed 1.3333 times area required by analysis. (use 4-#6 when ℄ Bearing are 12" or less on either side of ℄ Piles). This reinforcement area meets the requirement of AASHTO Article 8.17.1.

Beam reinforcement was determined by load factor design procedures.
For special cases 1 or 2 see this section, page 3.6-1.
See the following page for sections thru end bents showing typical reinforcement.

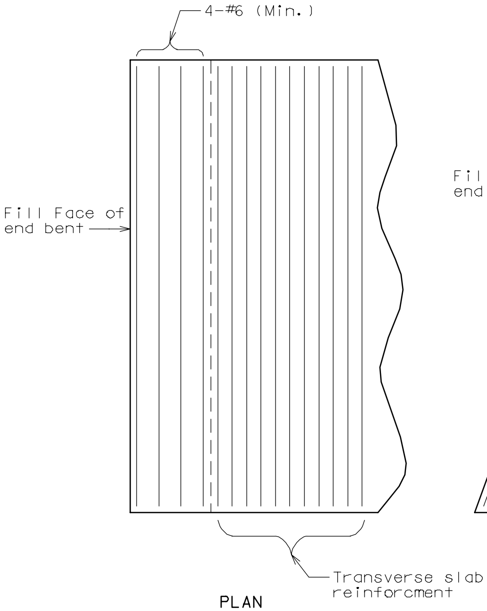
WIDE FLANGES, PLATE GIRDERS & PRESTRESSED GIRDERS



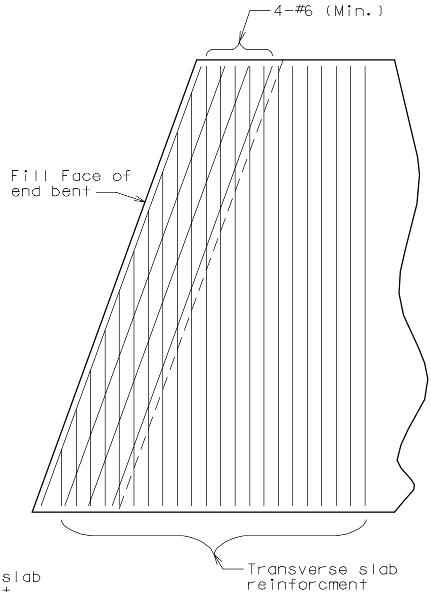
SECTION THRU
SQUARE END BENT



SECTION THRU
SKEWED END BENT



PLAN
SQUARE END BENT



PLAN
SKEWED END BENT

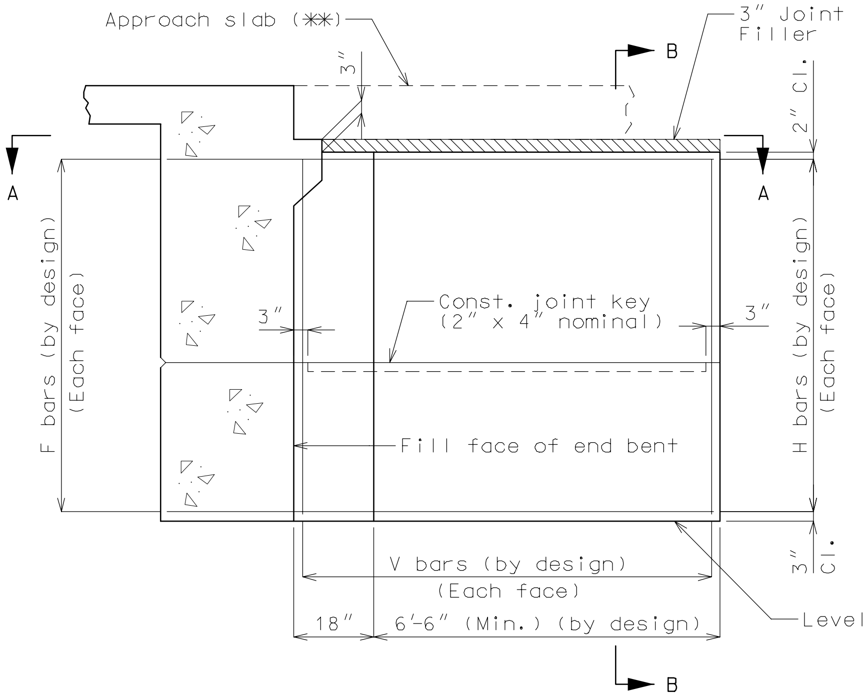
Note: Sections shown above are between girders and piles.
Prestressed I girders are shown in the sections above; Steel girders are similar.

1 Use same as bottom reinforcement.

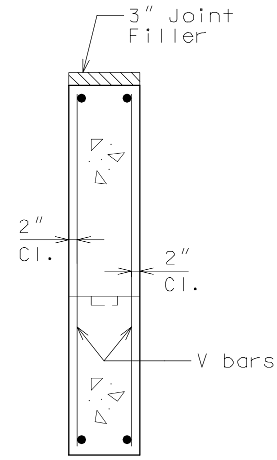
2 Use construction joint on steel structures only.

EARTHQUAKE LOADS AT END BENTS INTERMEDIATE WING (SEISMIC SHEAR WALL)

Reinforcement



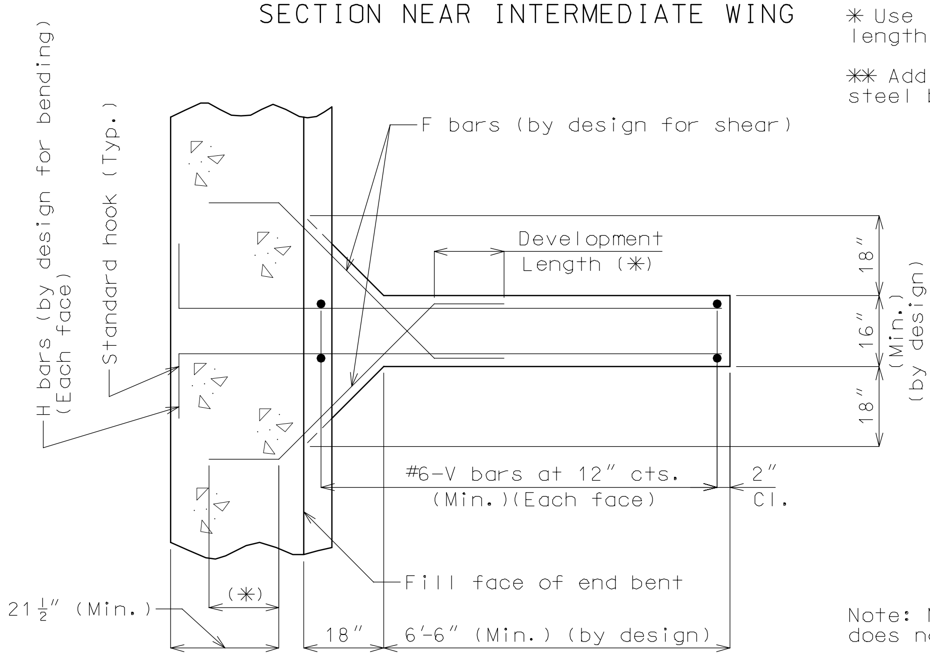
SECTION NEAR INTERMEDIATE WING



SECTION B-B

✱ Use 1.25 x development length for seismic design.

✱✱ Additional reinforcing steel by design if required.



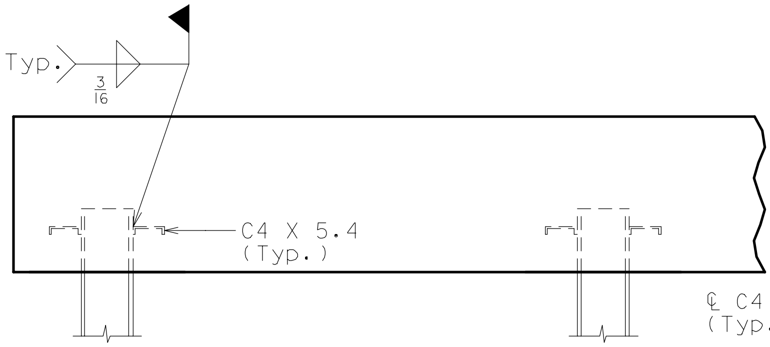
Note: Make sure reinforcement does not interfere with girders.

SECTION A-A

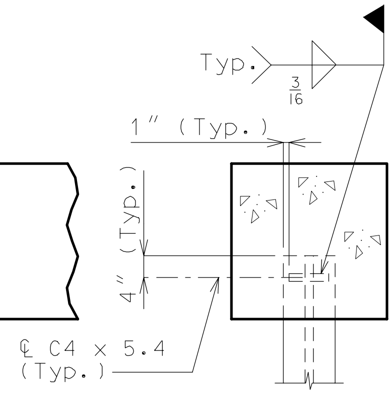
Reinforcement

ANCHORAGE OF PILES FOR SEISMIC PERFORMANCE CATEGORIES B, C & D.

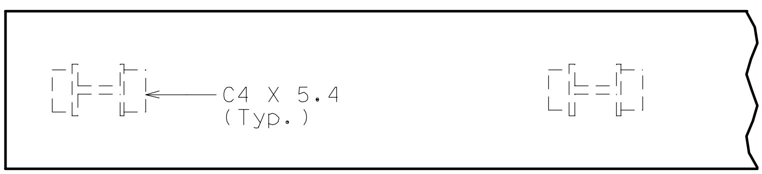
STEEL PILE



PART ELEVATION OF BEAM



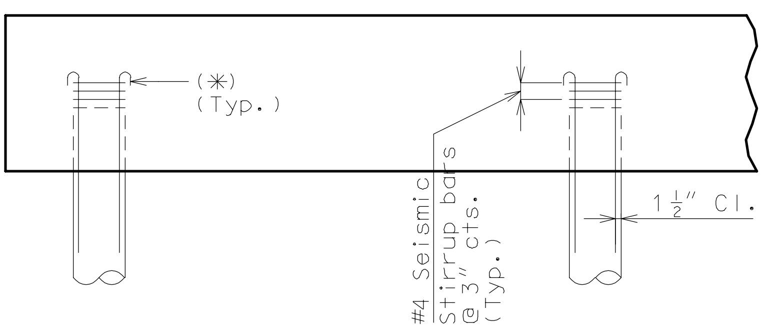
SECTION THRU BEAM



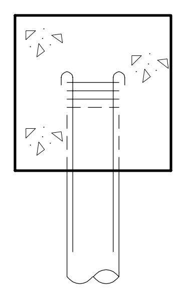
PART PLAN OF BEAM

Note: Channel shear connectors are to be used for all steel piles in end bent.

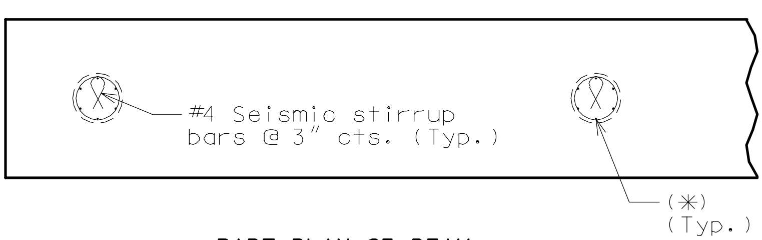
CAST-IN-PLACE PILE



PART ELEVATION OF BEAM



SECTION THRU BEAM



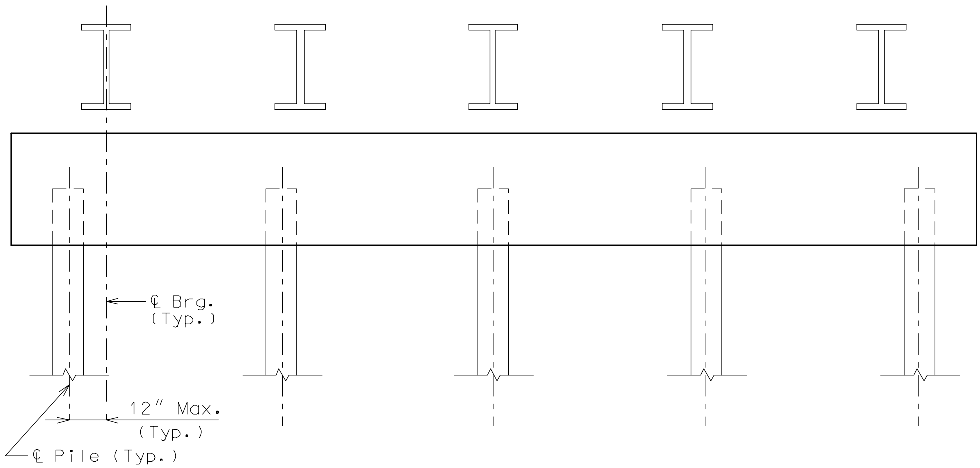
PART PLAN OF BEAM

(✳) See Bridge Manual Section 3.74 (Piling) for anchorage reinforcement required.

BEAM REINFORCEMENT SPECIAL CASES

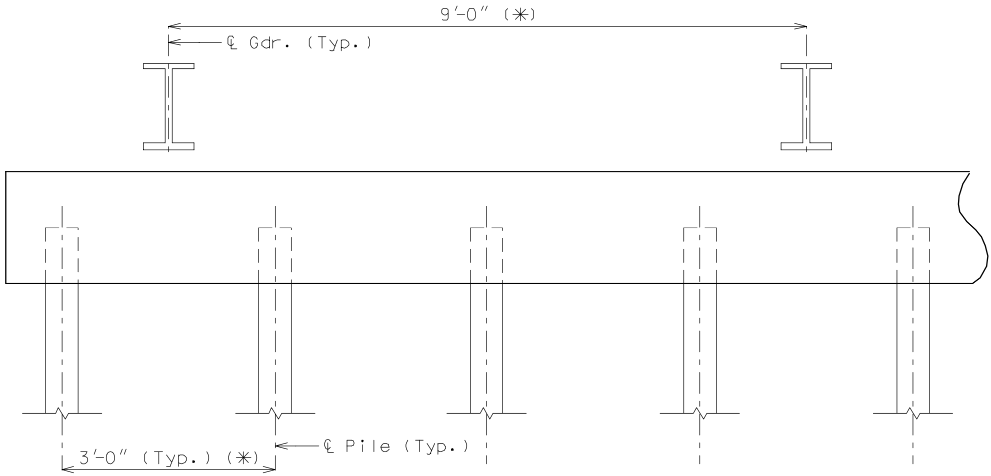
SPECIAL CASE I

If ℄ bearing is 12″ or less on either side of ℄ piles, for all piles (as shown above), use 4-#6 top and bottom and #4 at 12″ cts. (stirrups), regardless of pile size.



SPECIAL CASE II

When beam reinforcement is to be designed assuming piles to take equal force, design for negative moment in the beam over the interior piles.

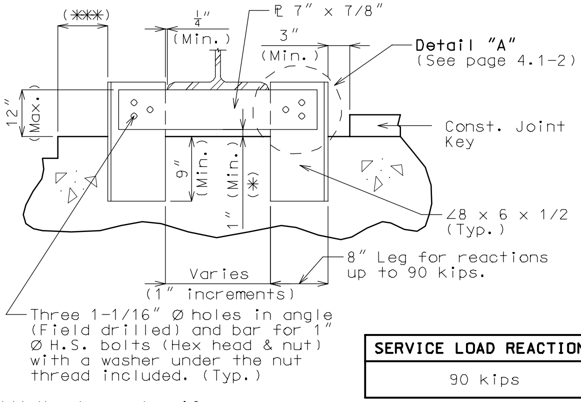


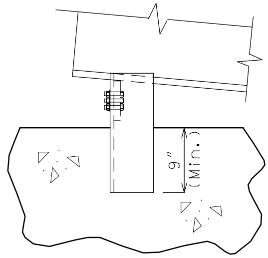
(✳) Dimensions shown are for illustration purposes only.

GIRDER CHAIRS FOR WIDE FLANGE BEAMS

Details

Plain Neoprene Bearing Pads are to be used on all integral bents if the pad size meets design criteria (including bearing taper). Otherwise use Laminated Bearing Pads. If design criteria such as minimum dead load or girder slope can not be met for the laminated bearing pads, use girder chairs up to maximum reaction 90 kips.





END ELEVATION

SERVICE LOAD REACTIONS	VERTICAL ANGLE	HORIZONTAL BAR
90 kips	8 X 6 X 1/2	7" X 7/8"

Use DL1 and 50#/Sq. Ft construction load for reactions.

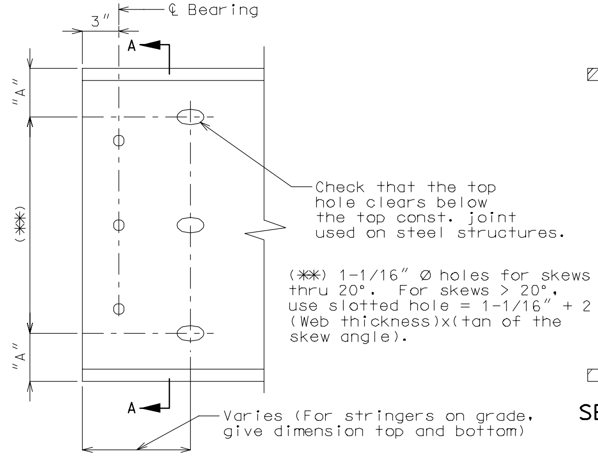
(✱) Use beam step if necessary.

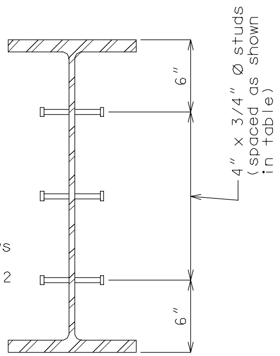
(✱✱✱) 3" Min. when using beam step.

FRONT ELEVATION

DETAILS OF GIRDER CHAIRS

REINFORCING HOLES FOR WIDE FLANGE BEAMS





SECTION A-A

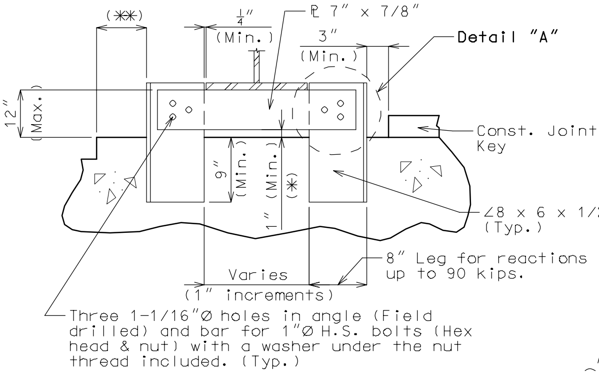
SECTION AT END OF STRINGER

WF BEAM DEPTH	STUD SPACING	"A"	REINFORCING HOLE SPACING
21"	2 spa. @ 4-1/2"	4"	2 equal spaces
24"	2 spa. @ 6"	4"	2 equal spaces
27"	2 spa. @ 7-1/2"	4-1/2"	2 equal spaces
30"	3 spa. @ 6"	4-1/2"	3 equal spaces
33"	3 spa. @ 7"	4-1/2"	3 equal spaces
36"	4 spa. @ 6"	4-1/2"	3 equal spaces

GIRDER CHAIRS FOR PLATE GIRDERS

Details

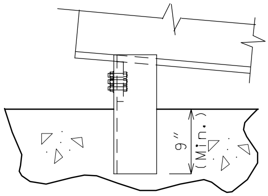
Plain Neoprene Bearing Pads are to be used on all integral bents if the pad size meets design criteria (including bearing taper). Otherwise use Laminated Bearing Pads. If design criteria such as minimum dead load or girder slope can not be met for the laminated bearing pads, use girder chairs up to maximum reaction 90 kips.



(✱) Use beam step if necessary.

(✱✱) 3" Min. when using beam step.

FRONT ELEVATION

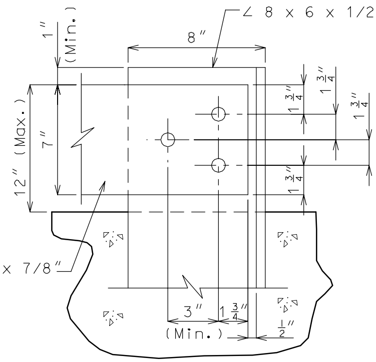


END ELEVATION

SERVICE LOAD REACTIONS	VERTICAL ANGLE	HORIZONTAL BAR
90 kips	8 X 6 X 1/2	7" X 7/8"

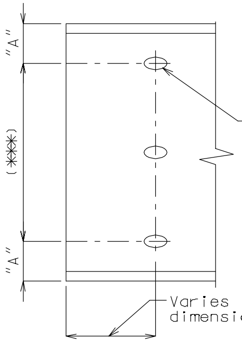
Use DL1 and 50#/Sq. Ft construction load for reactions.

DETAILS OF GIRDER CHAIRS



DETAIL "A"

REINFORCING HOLES FOR PLATE GIRDERS



Note:
Check the deadload (DL) on angles for girders 60" or larger.

Bearing stiffeners are to be designed for DL 1 and 50#/Sq. Ft construction load. (No web studs are required since bearing stiffener is provided).

Check that the top hole clears below the top const. joint used on steel structures.

PL GDR DEPTH	"A"	REINFORCING HOLE SPACING
39"	3-1/2"	4 equal spaces
42"	3-1/2"	5 equal spaces
48"	4"	5 equal spaces
54"	4-1/2"	6 equal spaces
60"	4"	8 equal spaces

Varies (For girders on grade, give dimension top and bottom)

SECTION AT END OF GIRDER

(✱✱✱) 1-1/16" Ø holes for skews thru 20°. For skews > 20°, use slotted hole = 1-1/16" + 2(Web thickness)x(tan of the skew angle).

CONCRETE PILES (CAST-IN-PLACES)

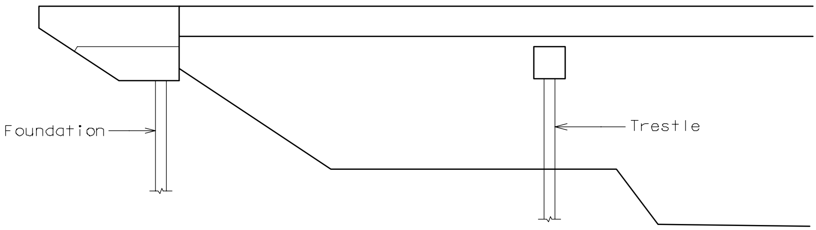
Details

The details of cast-in-place piles will be as indicated on Missouri Standard Plans (English Version) Std. Drawing 702.02., except that the shell and location type must be indicated on the Plans as specified on the Design Layout.

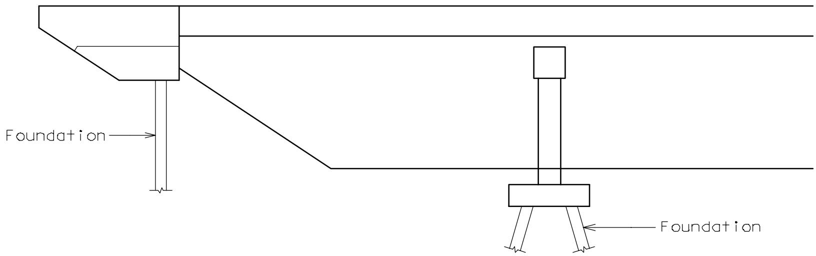
The KIND and TYPE of CIP pile shall be indicated in the "PILE DATA" table on Design Plans.

The TYPE of pile, trestle or foundation, may be selected from the illustrations shown below. When the illustrations indicate that there would be both trestle and foundation piles on the same structure, use all piles as trestle piles throughout the structure, regardless of the type of bent.

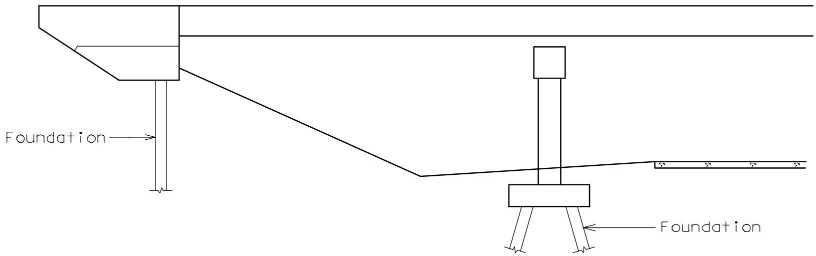
The shell, thick or thin, will not be indicated in the "PILE DATA" table, unless specified on the Design Layout.



STREAM CROSSING



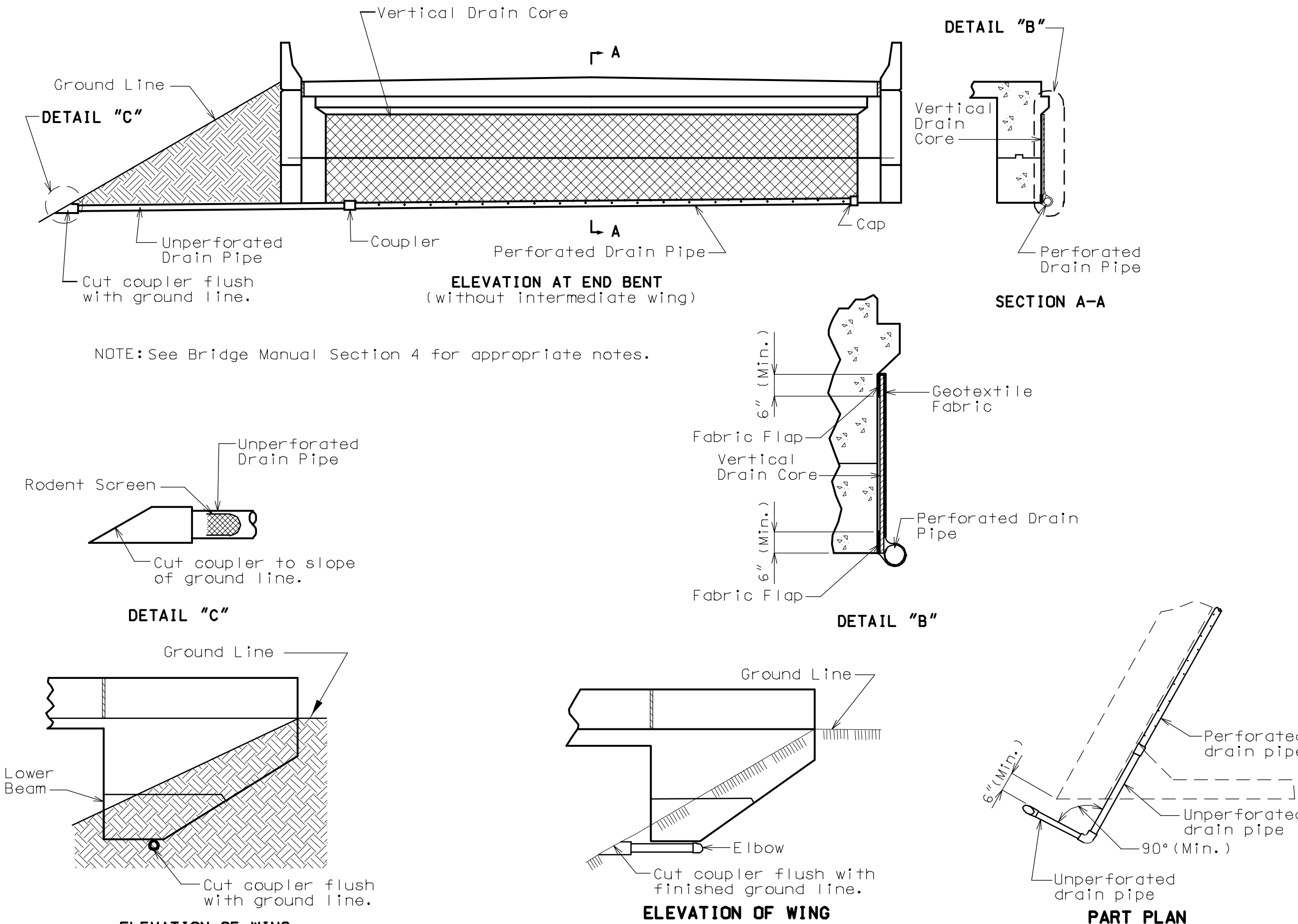
STREAM CROSSING



GRADE SEPARATION

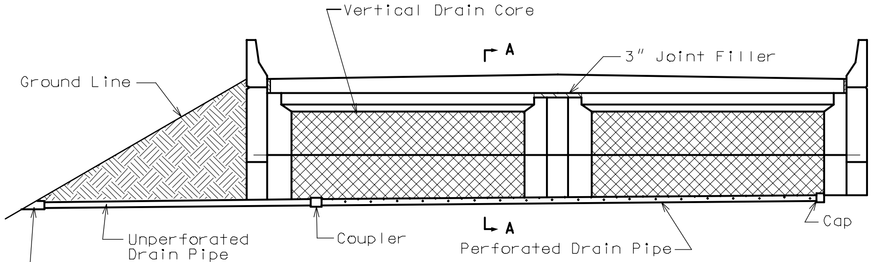
VERTICAL DRAIN AT INTEGRAL END BENTS

Details



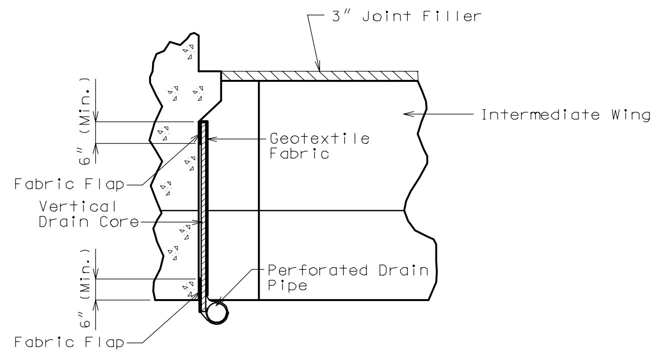
OPTIONAL BENT DRAIN ✳

✳ Only if rock is encountered at outside of wings.



ELEVATION AT END BENT
(with intermediate wing)

NOTE: See Bridge Manual Section 4 for appropriate notes.

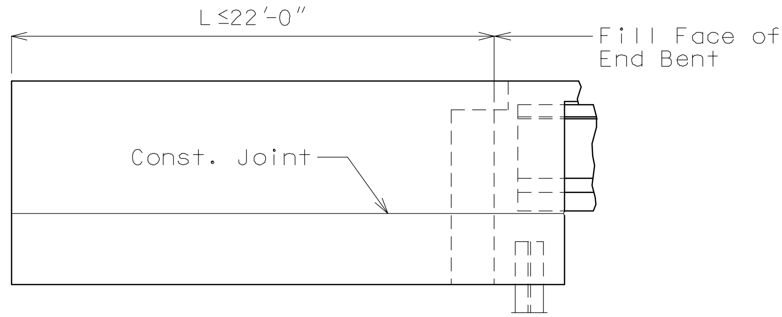


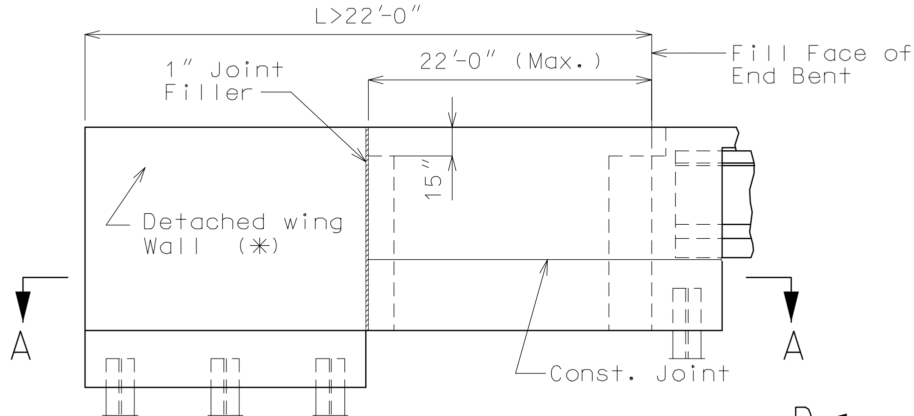
PART SECTION A-A

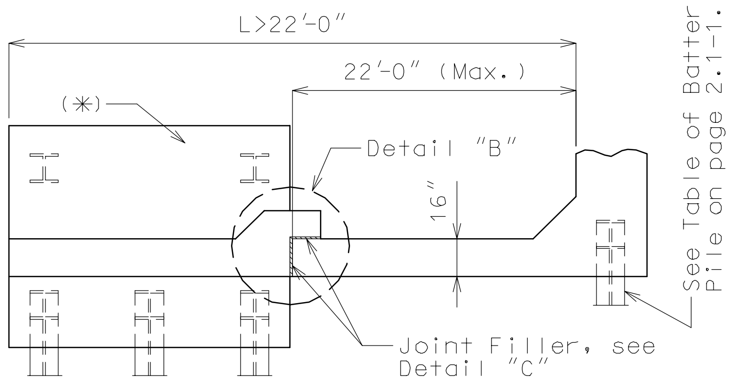
SQUARE WING/SQUARE APPROACH SLAB NOTCH

Design

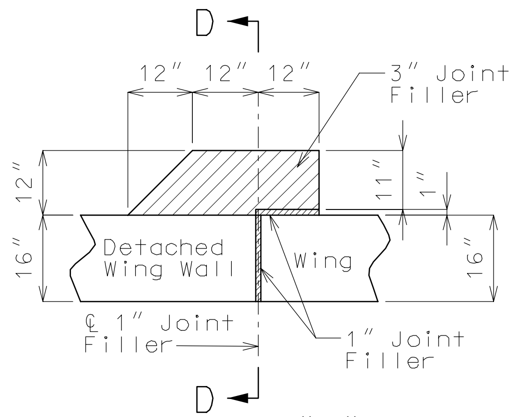
Wing With Detached Wing Wall



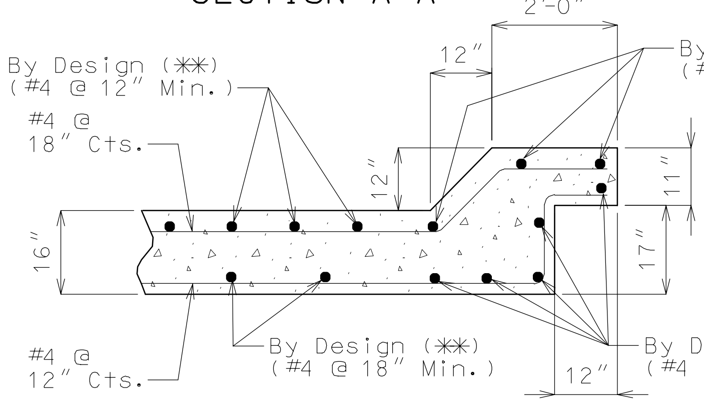




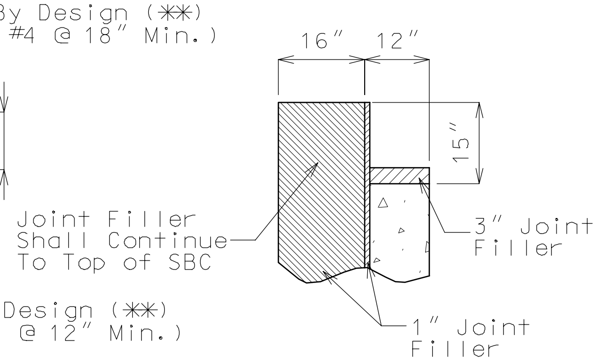
SECTION A-A



DETAIL "C"



DETAIL "B"



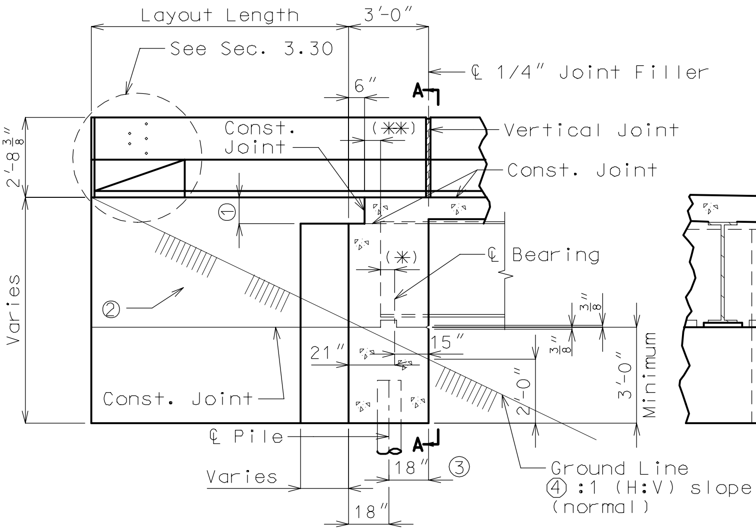
SECTION D-D

(✳) Detached wing wall shown is for illustration purpose only. Design detached wing wall as a retaining wall, see Section 3.62 of this manual.

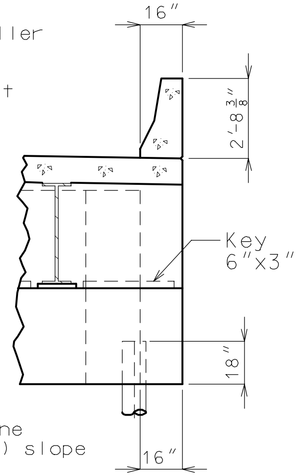
(✳✳) See Retaining Wall Design.

SQUARE WING/SQUARE APPROACH SLAB NOTCH **Dimensions**

WIDE FLANGES BEAMS AND PLATE GIRDERS



SECTION NEAR WING



SECTION A-A

① 12" Minimum at gutter line top of concrete.

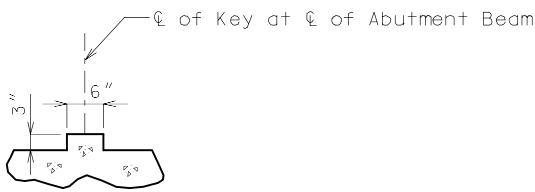
② All concrete in the end bent above top of beam and below top of slab shall be Class B-2, see proper notes in Section 4 Office Notes.

③ Provide a minimum of 6" Cl.from outside edge of pile to face of beam.

④ See Design Layout for maximum slope of spill fill.

(✱) Use 3" Min. when girder chairs are used and use 1" past the end of the bearing pad when bearing pads are used.

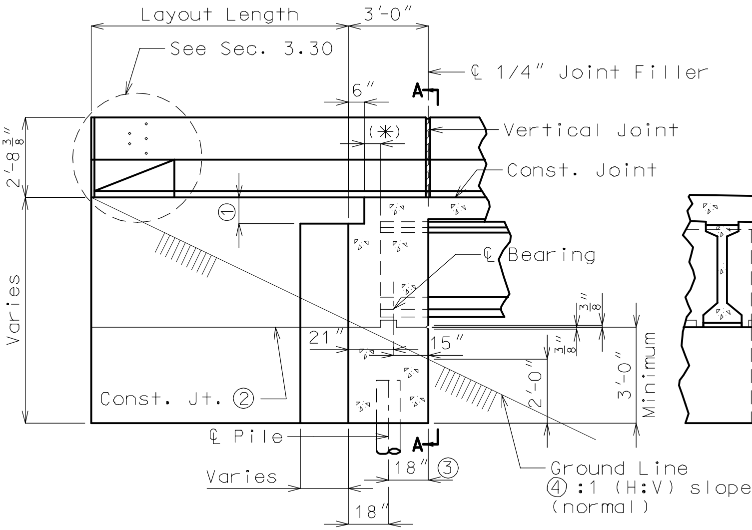
(✱✱) Keep 1-1/2" Min. clear cover for a #6 bar reinf. between approach notch and girder. Increase abutment beam width (1" increments) to get the 1-1/2" clear cover if necessary.



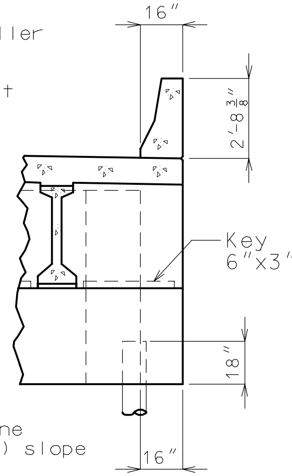
DETAIL OF KEYED CONST. JOINT

SQUARE WING/SQUARE APPROACH SLAB NOTCH **Dimensions**

PRESTRESSED GIRDERS



SECTION NEAR WING



SECTION A-A

Note:

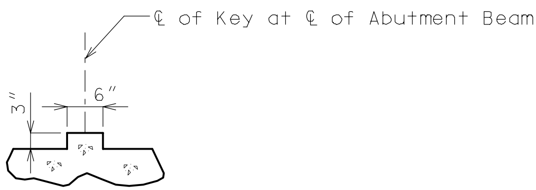
① 12" Minimum at gutter line top of concrete.

② All concrete in the end bent above top of beam and below top of slab shall be Class B-2, see proper notes in Section 4 Office Notes.

③ Provide a minimum of 6" Cl. from outside edge of pile to face of beam.

④ See Design Layout for maximum slope of spill fill.

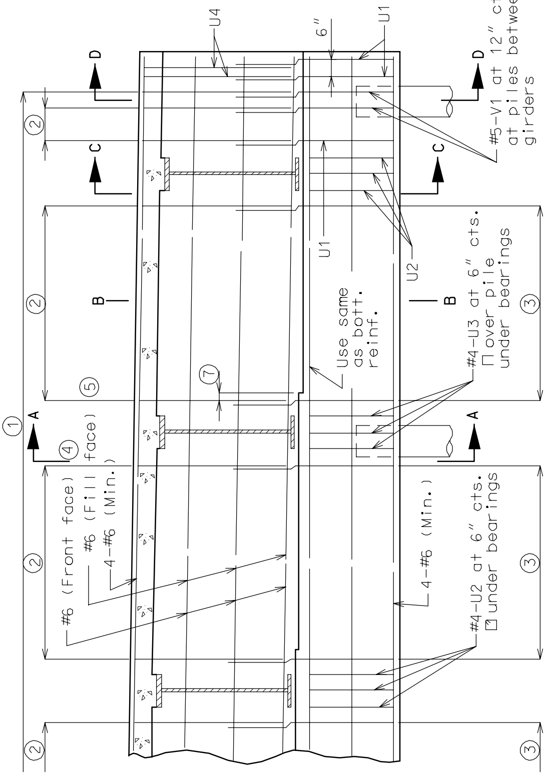
(✳) Keep 1-1/2" Min. clear cover for a #6 bar reinforcement between approach notch and girder. Increase abutment beam width (1" increments) to get the 1-1/2" clear cover if necessary.



DETAIL OF KEYED CONST. JOINT

SQUARE WING/SQUARE APPROACH SLAB NOTCH
WIDE FLANGES & PLATE GIRDERS

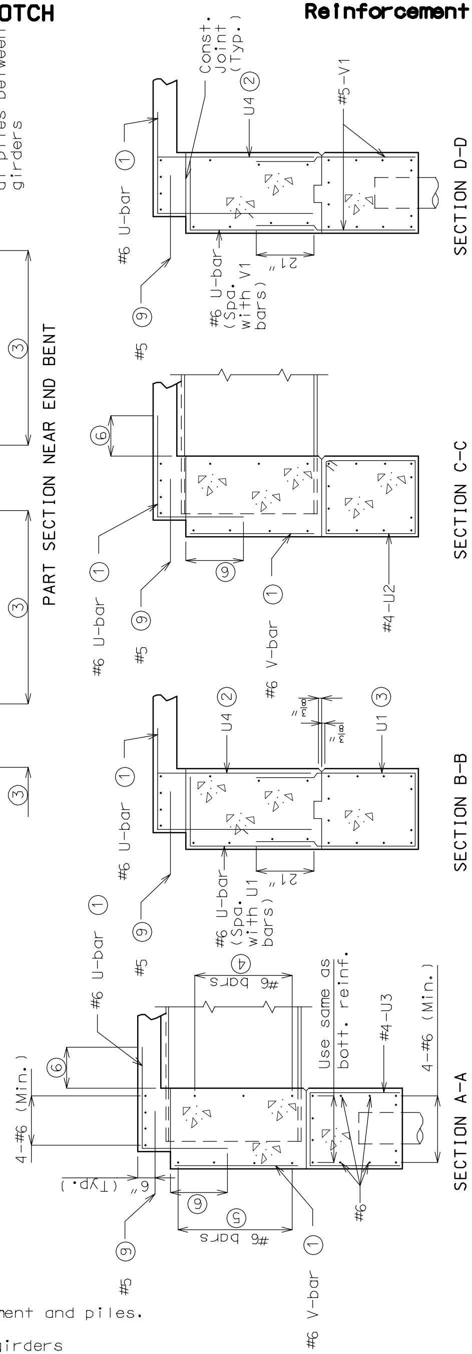
Reinforcement



PART SECTION NEAR END BENT

Place U1, U2, U3, U4, and V1 bars parallel to ℄ Roadway.

1. #6 U-bar (horiz. leg placed parallel to ℄ Roadway) and #6 V-bar or U-bar @ 9" cts. min. (Between barrier curbs).
2. #5-U4 at 12" cts. ⊓ - spaced with U1 and V1 bars.
3. U1 at 12" cts. ⊔ - spaced between piles and girders. #5 bars, except special cases listed on Page 3.6-1.
4. See tables on pages 4.1-1, 4.1-2 of this section for 1-1/16" Ø hole spacing for #6 reinf. bars.
5. Same number of bars as 1-1/16" Ø holes in stringer or girder.
6. By design - development length (top bars) min., see Section 2.4.
7. Stirrups shall clear step by 1-1/2" min., if not lengthen step or skew step.
9. #5 bars, 2'-6" long, spaced at 12" cts. along ℄ bent. Bars placed parallel to ℄ Rdwy.



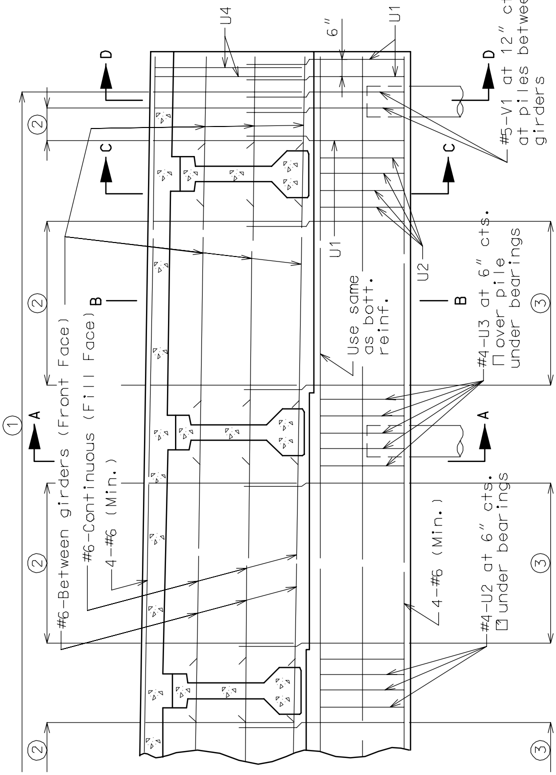
Place note on plans if Girder Chairs are used:
Shift the reinforcing steel to keep 1-1/2" clearance of the angles of the girder chairs.

Keep 1-1/2" clearance between shear reinforcement and piles.

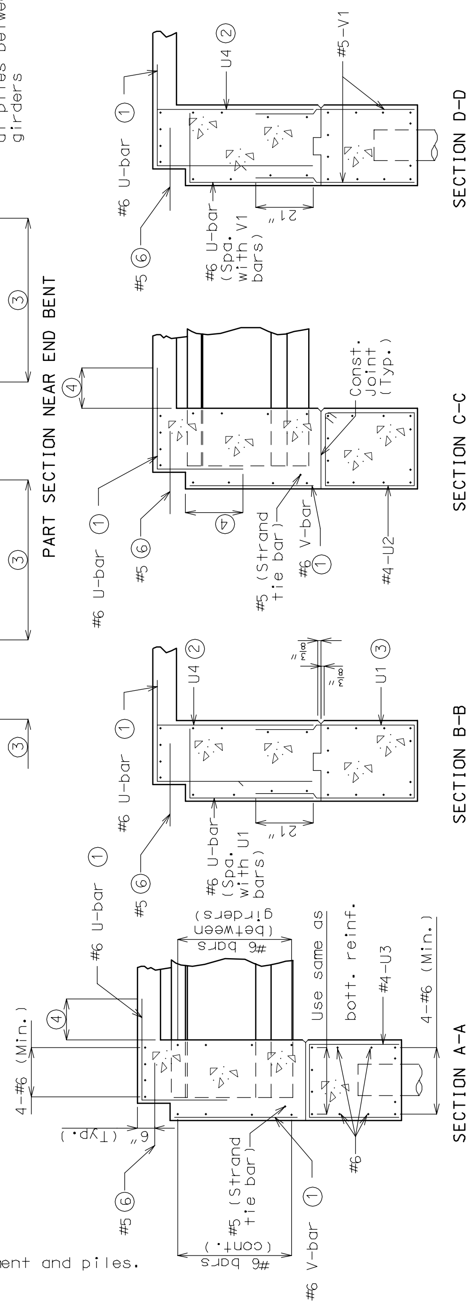
(Replace U1 bars with U3 bars at piles under girders and with V1 bars at piles between girders.)

SQUARE WING/SQUARE APPROACH SLAB NOTCH **Reinforcement**

PRESTRESSED GIRDERS



PART SECTION NEAR END BENT



Place U1, U2, U3, U4, and V1 bars parallel to ℄ Roadway.

① #6 U-bar ⌈ (horiz. leg placed parallel to ℄ Roadway) and #6 V-bar or U-bar @ 9" cts. min. (Between barrier curbs).

② #5-U4 at 12" cts. ⊓ - spaced with U1 and V1 bars.

③ U1 at 12" cts. ⊔ - spaced between piles and girders.
(Replace U1 bars with U3 bars at piles under girders and with V1 bars at piles between girders). #5 bars, except special cases listed on Page3.6-1.

④ By design - development length (top bars) min., see Section 2.4.

⑥ #5 bars, 2'-6" long, spaced at 12" cts. along ℄ bent. Bars placed parallel to ℄ Rdwy.

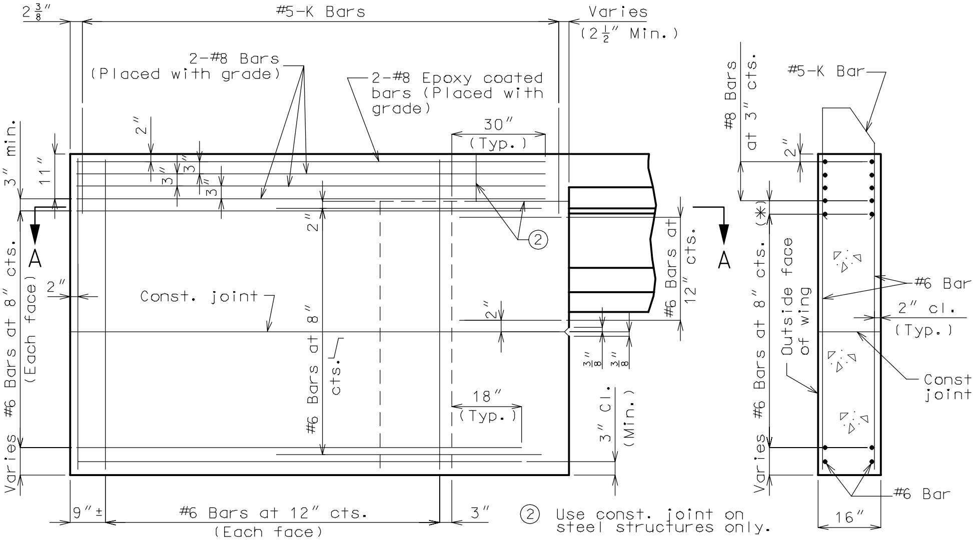
Place note on plans if girder chairs are used:
Shift the reinforcing steel to keep 1-1/2" clearance of the angles of the girder chairs.

Keep 1-1/2" clearance between shear reinforcement and piles.

SQUARE WING/SQUARE APPROACH SLAB NOTCH

Reinforcement

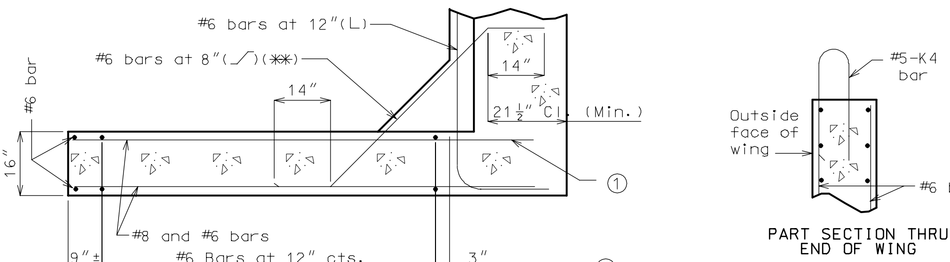
WIDE FLANGES, PLATE GIRDERS & PRESTRESSED GIRDERS



ELEVATION OF WING

PART SECTION THRU WING

(*) Keep a min. of 3" ctr. to ctr. spacing between #6 bars placed horizontally and #8 bars placed with grade.

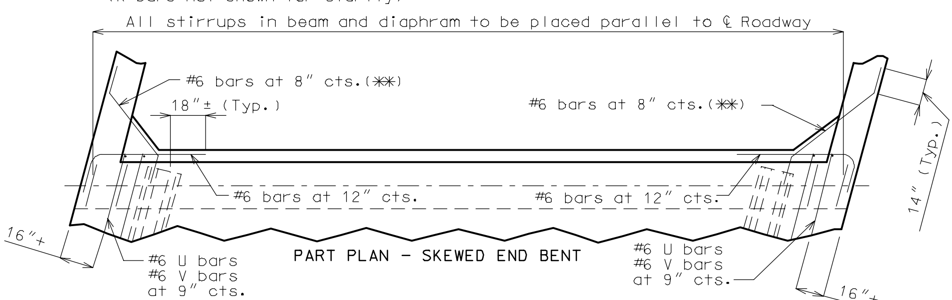


SECTION A-A (SQUARE)

(K bars not shown for clarity)

PART SECTION THRU END OF WING

① Use 90° standard hook in SPC B, C, & D.



PART PLAN - SKEWED END BENT

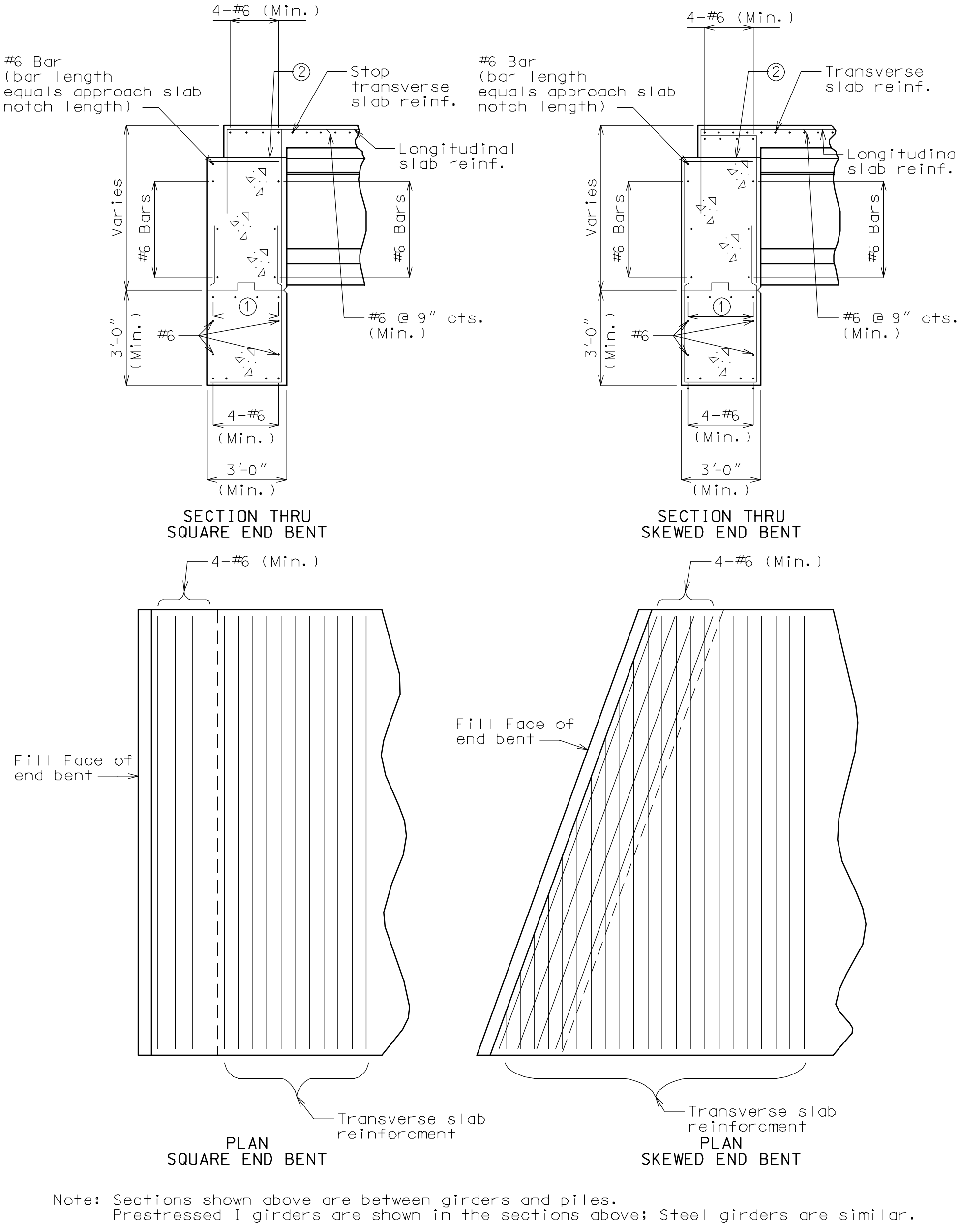
<u>** Place note on plans</u>

Bend ____ F bars in field to clear girder.

Note: See Bridge Manual Section 3.30 for barrier curb details and spacing of K bars. Prestressed I-Girders shown in details, Steel Girders similar.

SQUARE WING/SQUARE APPROACH SLAB NOTCH
Reinforcement

WIDE FLANGES, PLATE GIRDERS & PRESTRESSED GIRDERS



Note: Sections shown above are between girders and piles.
Prestressed I girders are shown in the sections above; Steel girders are similar.

1 Use same as bottom reinforcement.

2 Use construction joint on steel structures <u>only</u>.